JULY 1973 60 CENTS

Popular Science

THE What's New MAGAZINE

NEW TAKE-ALONG TELEPHONES Give You Pushbutton Calling to Any Phone Number

Detroit Hot Line – WHAT'S COMING IN THE '74 CARS

INGENIOUS INVENTIONS From New York's Patent Exposition

How Science Is Solving THE MYSTERIES OF THE NORTHERN LIGHTS

What's the "Best" Color for Your Car?

Amazing New Alternator Delivers 60-Cycle Power Over a Wide Range of RPM's

DRIVABILITY PROBLEMS? How to Troubleshoot Your Car's Emission Controls

Now You Can Make Your Own 25-Foot INFLATABLE DOME

...plus 34 more exciting articles and features – see contents on page 6

"King of the Surf"

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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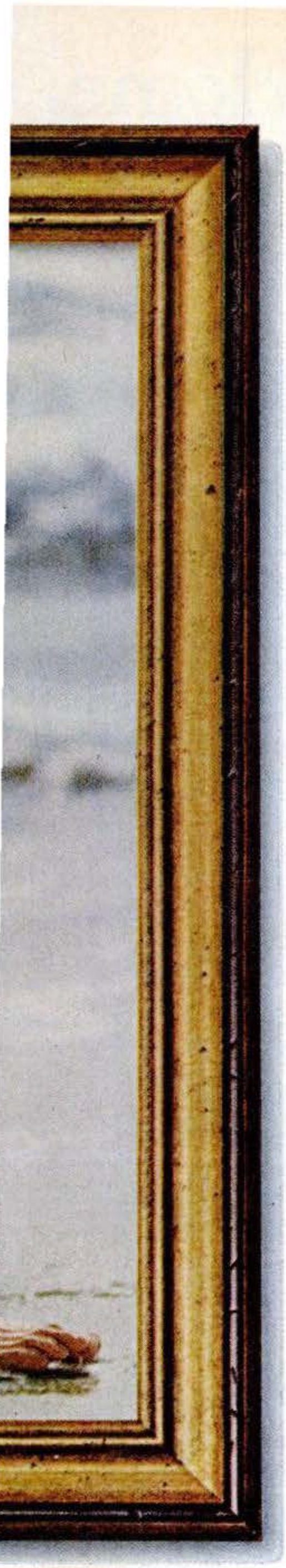

How good it is

Winston tastes good, when a cigarette should.

PACK OR BOX

This One

BOX: 20 mg."tar", 1.3 mg. nicotine, PACK: 20 mg."tar", 1.4 mg. n

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Introducing the GMC MotorHome. It doesn't ride like a truck. It doesn't look like a box.

1. A NEW ERA IN MOTORHOMES IS BEGINNING.

Before we started building our MotorHome, we studied every other type of motorhome that exists.

We found that the simpler the basic construction, the fewer the problems. So we started with a strong, durable, steel perimeter frame and attached to this a cage of heavy aluminum ribs.

On top of this, we bonded both aluminum and fiberglass panels molded to a smooth finish. It's the same construction people are flying all over the world in.

Except now you'll be driving.

Then we sprayed the interior with a thick, rigid polyurethane foam for thermal insulation and noise suppression.

Next we assigned a 3-man team to install the interior. From beginning to end.

If that sounds like a return to old-fashioned pride of craftsmanship, you're absolutely right.

2. MORE POWER TO YOU.

To give you the excellent road performance, we installed a 455-cubic-inch V8 engine up front and coupled it to a 3-speed Turbo Hydra-matic transmission. We coupled that to a front wheel drive unit with a 3 to 1 ratio and put it all on top of torsion bar springs and stabilizer bar.

With our low overall body weight, it all means getting up to highway speeds quickly. Excellent traction. Excellent weight distribution.

3. A MOTORHOME IS NO FUN IF IT'S NO FUN TO MOTOR IN.

We took our basic construction and raised it only 15" from the ground. This puts the center of gravity only 37 inches above the ground. For easy handling.

See the rear wheels. We put one behind the other for four reasons: To give you a wider base. More room inside. Greater stability than you'd have with dual wheels. And so we could place a special air spring between the two wheels to pass the bumps from one to the other

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instead of to you!

These air springs are the only ones of their kind on motorhomes.

To keep the weight and balance of the interior within design limits, we fed all the data into a computer. It fed back what we needed to put things where they belong.

4. ABOUT OUR SIX-WHEEL BRAKING SYSTEM.

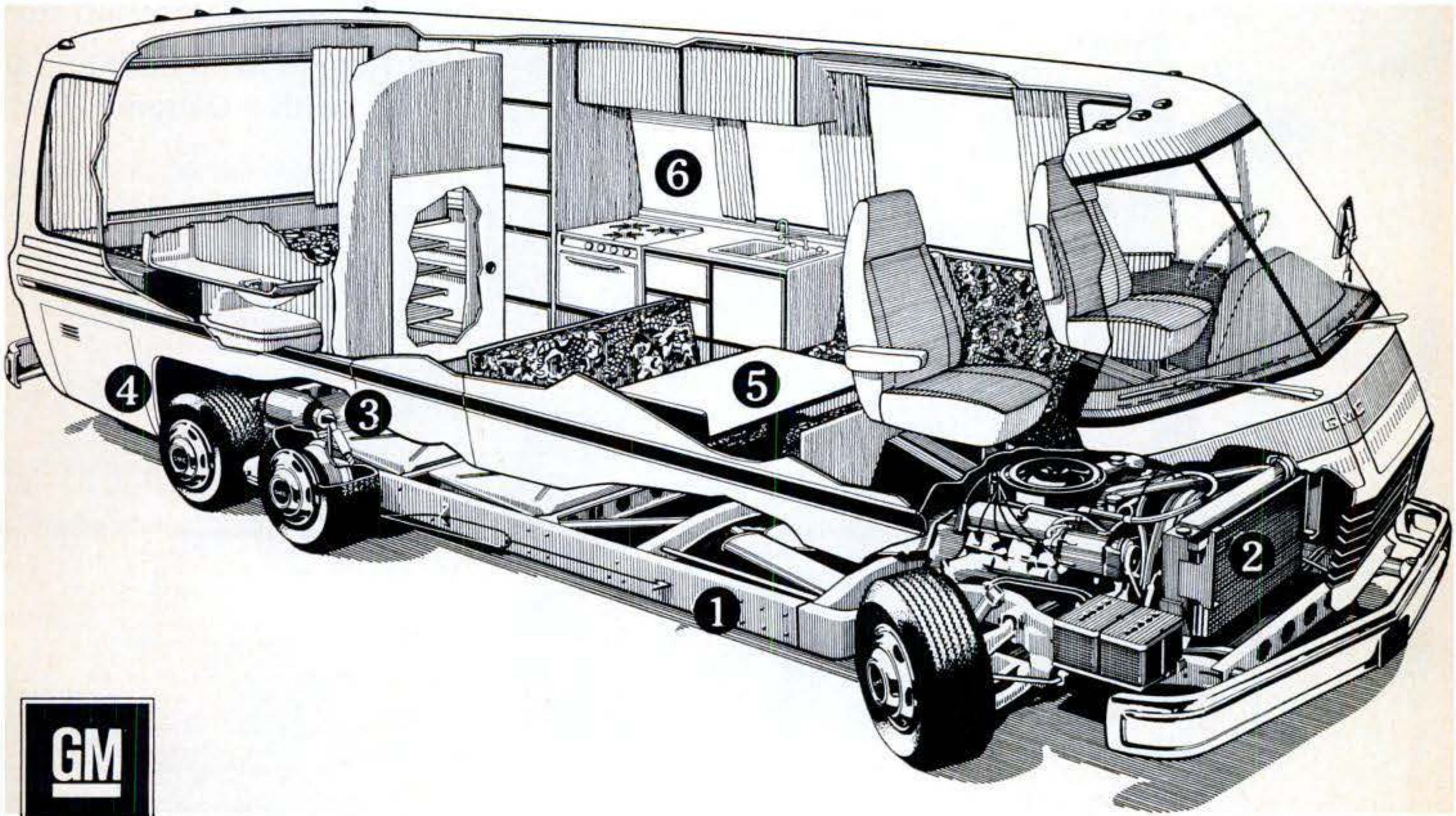
middle, a double sink, 6-cubic-foot refrigerator (it's electric so there's no pilot light that'll blow out), a range and oven with exhaust hood. There's also a bath with all the necessities plus ample cabinet space.

That's one floor plan. There are 14 more available.

6. WE INCLUDED TOP INTERIOR DESIGNERS IN OUR PLANS.

7. ONE-STOP SERVICE. AFTER-HOUR ASSISTANCE.

Your GMC MotorHome dealer services everything he sells. Inside and out. From the engine to the air conditioner and furnace. And there's a toll-free number you can call and immediately get the number of the nearest MotorHome dealer representative available for after-hour assistance.



GM
MARK OF EXCELLENCE

In addition to power steering, there's a six-wheel braking system with power disc brakes up front and four large finned-drum power brakes in the rear, plus an available leveling device operated from the driver's compartment for parking on uneven ground.

Incidentally, the parking brake grabs all four rear wheels.

5. CHOOSE FROM 15 DIFFERENT FLOOR PLANS. TWO LENGTHS.

The GMC MotorHome is available in 23- and 26-foot lengths. The standard 26' floor plan includes a dinette that converts to a double bed opposite a sofa that turns into double bunks. In the

To put the finishing touches on the inside, we had *House and Garden* magazine's interior designers help us.

The driver and passenger seats are high, contoured seats with built-in arm rests. This high-level seating arrangement, combined with the big, wide-angle windshield, offers you panoramic visibility.

Every counter top has rounded corners. All cabinet knobs are eliminated. Every hinge is concealed.

There are thick, shag or cut pile carpets. And wood-grained vinyl on the walls and cabinets.

You also get a choice of four color-coordinated interior decors.

For our 28-page, four-color catalog, write GMC MotorHome Headquarters, Drawer Y, Dept. 116, Lansing, Mich. 48909.

Better yet, see your GMC MotorHome dealer. He'll be glad to show you around the house. Have a good life.

GMC

The MotorHome from General Motors.

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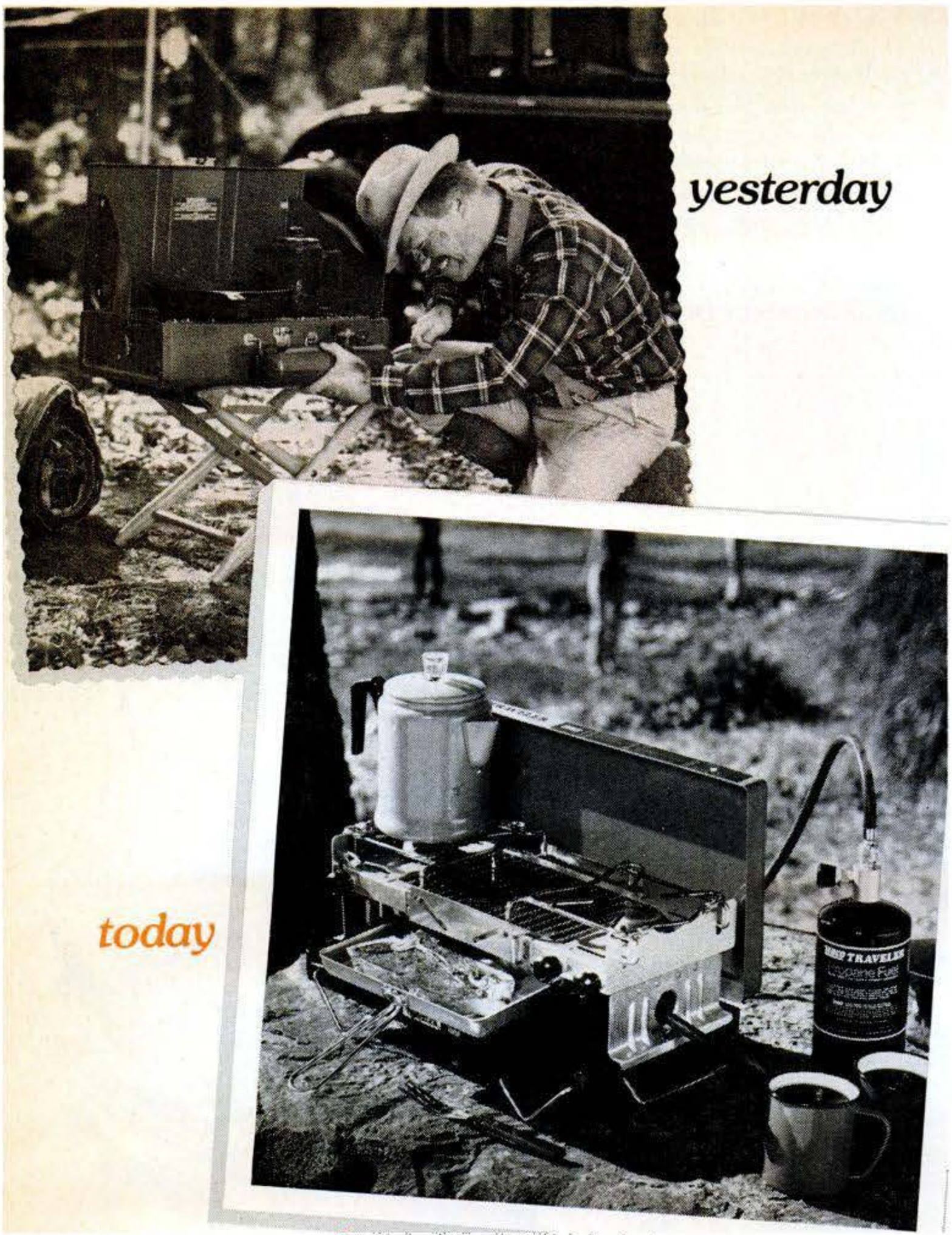

times change

Time was, when the only fuel better than wood for cooking outdoors was gasoline. But gasoline was smoky, smelly, and troublesome to handle. And keeping a gasoline-fueled camp stove pumped up was as bothersome as fixing a flat tire.

That's in the past.

Today there's a new fuel in the picture—*propane*—the perfect fuel for modern camping. And there's the Traveler Titan by Zebco—the perfect picture of convenience, efficiency and operating safety! Two big 6,400 BTU top burners handle big meals with little effort, and a unique broiler-grill combination broils a steak in just 7 minutes! The Titan connects in an instant to a propane cylinder or tank, and provides constant, even flame, without bothersome pumping or troublesome filling! And there's no smoke to blacken pans, no odor to spoil the taste of food.

See the Titan at your camping products dealer. And see the complete line of outstanding Traveler by Zebco propane appliances—stoves, heaters, lights—made for camping *today.*

Times change. The good times get better with Traveler by Zebco!

TRAVELER

by **ZEBCO**

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Tunneling Through the Earth with Monster Moles

The *Real* 200-mph, 38-mpg, Under-$3000 BD-5 Plane

Two Sleek New Motor Homes You Drive Like a Car

Build a Super-Strong Box-Beam Vacation Home

How to Keep Cool and Dry with a Dehumidifier

JULY 1973
Vol. 203, No. 1

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This is a stripped-down Subaru Station Wagon

Here's what you get:

1. Front wheel drive.
2. AM pushbutton radio.
3. 4-wheel independent suspension.
4. New 1400cc engine.
5. Whitewall radial tires with styled covers.
6. Rack and pinion steering.
7. MacPherson Strut front suspension.
8. 4-speed synchromesh transmission.
9. Tinted glass all around.
10. Economy—around 25 mpg on regular.
11. Fully-reclining, high-back bucket seats.
12. Undercoating and nylon carpeting.
13. Cigarette lighter.
14. Flow-through ventilation.
15. Heater and defroster.
16. Impact-absorbing steering wheel.
17. Bumpers that qualify for insurance discount.
18. Fire-retardant upholstery.
19. Recessed door locks.
20. Hatch & tailgate for height & low-lift loading.
21. Floor-to-dash center console.
22. Adjustable heavy-duty suspension.
23. Meets newest U.S. emission standards.
24. 12-month warranty.

This is a fully-equipped Subaru Station Wagon

Here's what you get:

1. Front wheel drive.
2. AM pushbutton radio.
3. 4-wheel independent suspension.
4. New 1400cc engine.
5. Whitewall radial tires with styled covers.
6. Rack and pinion steering.
7. MacPherson Strut front suspension.
8. 4-speed synchromesh transmission.
9. Tinted glass all around.
10. Economy—around 25 mpg on regular.
11. Fully-reclining, high-back bucket seats.
12. Undercoating and nylon carpeting.
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14. Flow-through ventilation.
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THE What's New MAGAZINE™

JULY 1973 Founded in 1872/Vol. 203 No. 1

HIGHLIGHTS OF THIS ISSUE:

New Take-Along Telephones Give You Pushbutton Calling to Any Number PAGE 60

This amazing phone system—Dynatac—could handle thousands of calls simultaneously, patching yours directly into a phone exchange.

13 Ingenious Inventions from Patexpo '73 PAGE 68

Presenting a baker's dozen of dazzling gadgets from New York's International Patent and Licensing Exposition.

Solving the Mystery of the Northern Lights PAGE 82

PS reporter Bob Gannon flew aboard an Air Force plane on a zigzagging 4000-mile course with a research team. Here's his exciting report.

Is There a "Best" Color for Your Car? PAGE 86

There's more to paint than looks—for safety your car should be visible in any weather. And what about durability, resale value?

Your Own Inflatable Dome—from a Kit PAGE 90

You've read about those air-supported structures that cover hundreds of acres. Now here's a bubble building designed with you in mind.

COVER PHOTO BY A. J. HAND

What's New...

CARS AND DRIVING

Norbye/Dunne Report: The 4-Wheel-Drive Multipurpose Cars 48
The '74 Cars: More Changes Than You Expected 64
Is There a "Best" Color for Your Car? 86
Troubleshooting Your Car's Emission-Control System 112

SCIENCE AND INVENTIONS

Typewriter Has Built-In Eraser . . 12
New Alternator Delivers 60-Cycle Power at Any Speed 38
World's Tallest in Toronto 66
13 Inventions from Patexpo '73 . 68
How Science Is Solving the Mystery of the Northern Lights . . 82

SPECIAL REPORTS

Take-Along Telephones Give You Pushbutton Calling 60
Beat the Squint—with the Right Sunglasses 97

What's New DIGEST

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Inflatable Bumper 74
Hang-Up House 75
All-Wing Vehicle 76
What's New in Boating 77
What's New in Tools 78
What's New in Home Improvement 79
What's New in Electronics 80
What's New for Your Car 81

HOME AND SHOP

Now—Mow with a Wankel 18
Plastic That Won't Tear 41
Your Own Inflatable Dome: Make It from a Kit 90
Leisure Home 5: Stretched Hex Doubles Your View 93
Picnic Table Folds for Travel . . . 94
Easy-Apply Teflon Film Puts the Skids on Home and Shop . . 100
No Slipping and Sliding—This Plastic Stays Put! 102
Make a Modular Planter 108

ELECTRONICS

Automatic Garage Light Control . 110
Plug-In Helper for Quick Circuit Design 118
TMX: It Theftproofs Your Car . . 119

OUTDOOR RECREATION

Three New Firearms 63
The Little Outboards: Cheap, Portable Power for Small Boats . . 70
Benelli 750: First 6-Cylinder Superbike 73
Keep Pool Water Swimmable . . . 104
Polluted Waterway? Float a Freshwater Pool 106
Trailer Mirrors—Eyes Behind Your Head 111

EVERY MONTH

PS Readers Talk Back 8
"Say, Smokey—" 16
Look and Listen 20
Science Newsfront 28
Detroit Report 34
The View Down the Road 36
Recreation Roundup 42
New Ideas from the Inventors . . . 56
PS: What's News 59
Shop Talk 117
Taking Care of Your Car 120
Wordless Workshop 122

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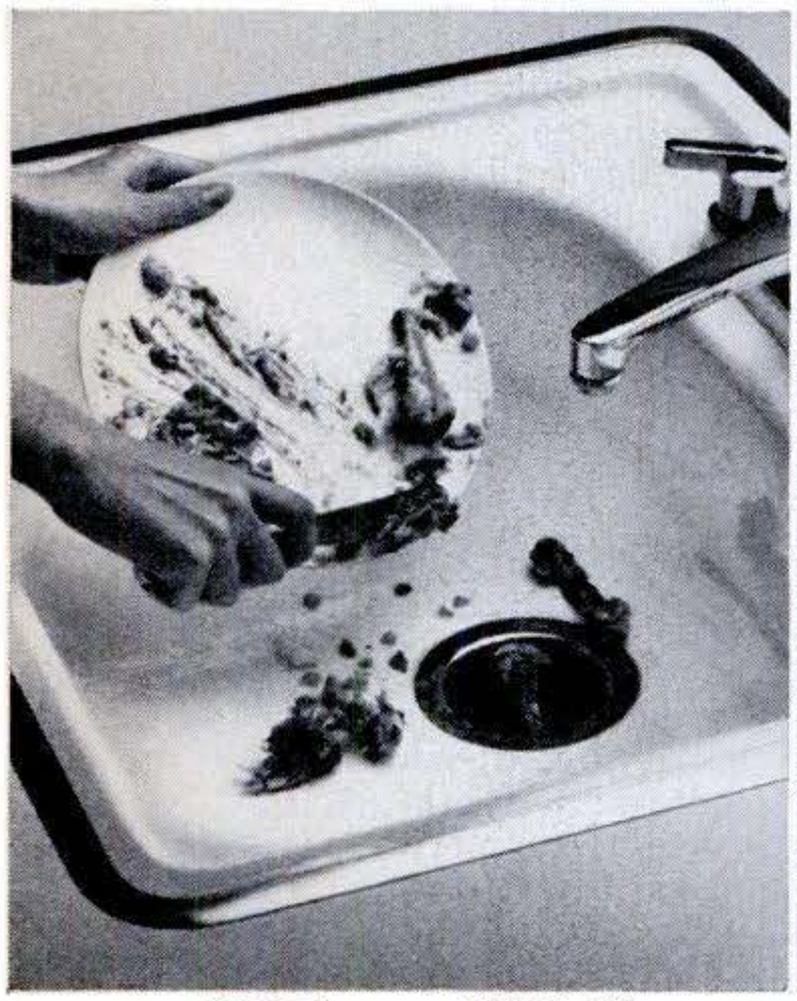
General Electric does away with all the things you don't like about dinner.



GE Disposall® Unit

GE Potscrubber

GE Compactor

Now, you hardly ever have to scrape dishes, wash plates, scrub pots or get rid of the after dinner mess.

We take care of it all.

When we're finished it looks like you never even started dinner.

The GE Disposall unit.

This big eater will gobble up whatever juicy leftovers the dog doesn't want (as well as things like chicken bones, fish bones, potato peels and egg shells). It will do it quickly, without a lot of fuss.

The GE Potscrubber Dishwasher.

This is the tough guy. It has a Power Scrub™ Cycle that not only cleans pots and pans without any help from you, it washes fine china and crystal as well. It also has a soft food disposer so you don't have to scrape or rinse pots or plates. Just tip off large and hard scraps.

The GE Compactor.

This wizard will make your cans, bottles, containers and other trash practically disappear. It will mash up the weekly trash for a family of four, into one tidy bundle.

We've done away with all the things you don't like about dinner and given you things you're going to love about cleaning up.

And we have another good thing that's as dependable as our products.

CUSTOMER CARE... SERVICE EVERYWHERE

Customer Care... Service Everywhere.™

This is our pledge that wherever you are, or go, in the U.S.A., you'll find a qualified GE serviceman nearby.

Should you ever need him.

After Dinner Appliances... another reason why GE is America's #1 Major Appliance Value.

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whose first love
is wilderness.

toiletries for men in a
rugged refreshing scent

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PS Readers Talk Back

Where you voice your views . . . and the editors do the listening

More on energy crisis

As a petroleum engineer, I have spent a number of frustrating years watching the developing energy crisis that you explain in "Why We Are Running Out of Gasoline" [Apr.]. With the help of the ecologists and the federal government, the day of reckoning has arrived even sooner.

It is ridiculous to impose on the entire nation federal emission standards which may be satisfactory for California (especially in Los Angeles) because of the topographical situation. As Mr. Edelson points out, to meet these standards nationwide will not only consume many dollars, but also a large portion of our energy, which is greatly needed for more important uses.

ROLAND REYNOLDS, Lafayette, La.

. . . The realities of the situation demand that we have cars that give more miles per gallon, and at the same time generate less pollution than Detroit's eight-cylinder hogs. The excellent cars made in Europe and Japan, which give 25 or more miles per gallon, prove that such cars can be made and that they meet all reasonable driving needs. If Detroit is incapable of facing the reality of the energy crisis, then it will probably find Washington stepping in, just as the government stepped in on safety and emissions.

DUDLEY DAVIS, Silver Spring, Md.

. . . And the pipeline

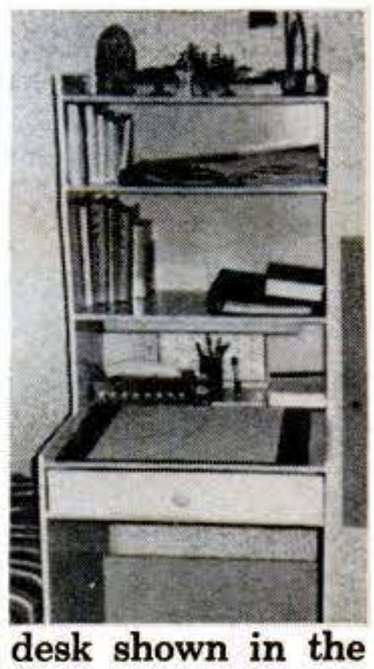
In your article "Alaska Pipeline Spins Off a Science Bonanza" [Jan.] many details were revealed regarding the overall benefits that can be gained, not only economically, but scientifically, by the hookup. I hope it finally gets built. At least before the environmental lobby finds out there are plenty of healthy caribou, and no electricity in the Capitol building.

STUART GREENSTREET, Orlando, Fla.

. . . It is amazing to me that an American, and especially an Alaskan, would put the convenience of caribou above the national interest [Readers Talk Back, Apr.]. Migrating caribou are in no great hurry and even a detour of a few miles wouldn't harm them. Even if we lost a few animals, it wouldn't compare with the value of the pipeline in bringing oil to the other states, especially with the impending energy crisis. Environmentalists are costing the country millions of dollars a year and giving the Middle East a very big stick to hold over our heads. Who comes first? You or the caribou?

M. M. BRANTLY, Dallas, Tex.

Happy desk builder



I built a desk from the article "Knockdown Desk is a Knockout" [Aug. '71]. After starting the project, I found the slots were impossible to cut. So I nailed the desk together with three-inch finishing nails. The result was the beautiful, sturdy desk shown in the picture. I added a drawer, fluorescent light, and a backing for the shelves.

MARK KLEIMAN, Brooklyn, N.Y.

Dishwasher works again

I've been enjoying your magazine for five years, but it's a distinct pleasure when an article saves me money.

My wife's dishwasher went out of operation not too long ago after we had a serviceman make some repairs. I was reluctant to call for service again because of high repair costs. Referring to "Secrets of Keeping Your Automatic Dishwasher Trouble-Free" [Jan. '72], I was able to trace the trouble to the timer, which I repaired without any difficulty. Besides giving me great personal satisfaction, I saved enough money to pay for several more years of POPULAR SCIENCE. Thanks.

L. A. KIRKPATRICK, Williamsport, Pa.

Open letter to Detroit

Attention Detroit: I will not buy any automobile that requires liquid-cooling systems, carburetors, crank-

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(means naturally fresh taste)

Salem's unique blend features natural menthol, not the kind made in laboratories. Like our superb tobaccos, our menthol is naturally grown. You'll get a taste that's not harsh or hot...a taste as naturally cool and fresh as Springtime.

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King or Super King.

SUPER KING: 21 mg. "tar", 1.5 mg. nicotine,
KING 19 mg. "tar", 1.3 mg. nicotine, av. per cigarette, FTC Report FEB. '73.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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DAP KWIK-SEAL®: the tub fixer. Seals joints and cracks watertight around tubs, sinks, showers, tiled areas. Bright white, resists mildew, stays flexible. Resets loose tiles and small fixtures, too.

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DAP Inc., Dayton, Ohio 45401
Subsidiary of Plough, Inc.

case oil changes, bias-ply tires, stick-shift transmissions, PCV valves, exhaust-gas recirculation, thermal reactors, catalytic converters, free-turning differentials, unprotected frames, etc.

I will buy a car that has a turbine or electric engine, continuously variable transmissions, controlled differentials, radial-ply tires, low-maintenance metal or plastic bodies, antiskid braking systems, front-wheel drive/front engine, rear-wheel drive, or four-wheel drive/midship engine.

G. C. CORRIGAN, Des Moines, Iowa

Beware of cadmium vapor

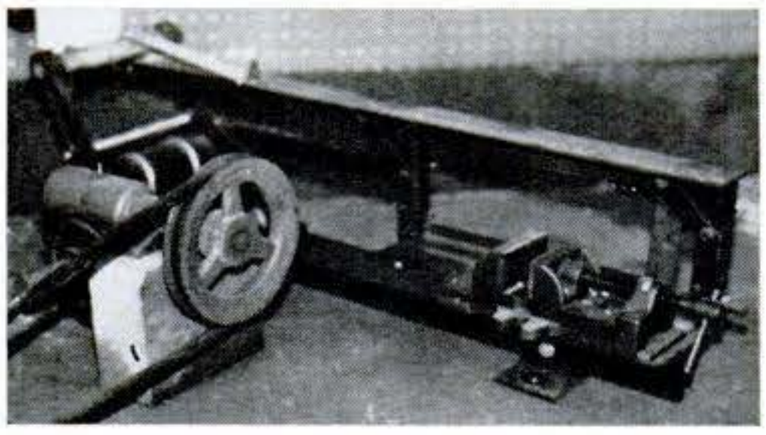
Nice idea in your project "Thin-Wall Conduit Stools: Bend them up yourself" [May]. But you must point out that cadmium plating on EMT will vaporize when you silver solder, braze, or weld the stuff. It is a dark yellow vapor, and it is extremely dangerous if inhaled. Some welders have died from inhaling it.

Cadmium is very irritating to tissues, too. If you get a tiny piece of it in a cut, you can count on blood poisoning if the particle isn't removed. Maybe another material would be better? In any case, don't breathe the smoke from hot cadmium.

MAX PEPKE, New York, N.Y.

Power hacksaw project

I had been looking for a power hacksaw for sometime and I found plans to build one in PS for February 1964. I modified the plans slightly to suit my shop equipment and used a garden-tractor transmission as a speed reducer instead of a V-belt reduction system.



I am pleased with the usefulness and accuracy of the final result.

WILLIAM GEMMILL, Jamison, Pa.

Delete no. 182, please

In your article and map, "PS' New Guide to Great Science and Technology Attractions" [May], Number 182 no longer exists. The Banks Railway Museum was last run in 1969. Since then the steam engine and its cars have been sold. All that's left is a few cars and one engine. It's too bad.

AMY STEINBACH, Banks, Ore.

. . . Tsk, tsk, tsk. I thought POPULAR SCIENCE was above listing "Weaponry" on the science map. Guns are something we can do without nowadays.

HARRY BARFDALE, Racine, Wis.

Too-high rider mowers?

"The '73 Mowers, Riders, and Tractors" [Mar.] shows the users getting tall in the saddle with a background of spacious lawns and stately trees whose lowest limbs are about six feet above the ground. Pity

the poor user whose trees have a growing habit. I have 48 such on my property, mostly mangoes, much lower than that. I suggest that one of the essential qualifications of a riding mower is how much you have to duck to get under uncooperative vegetation. Very few mower manufacturers give a damn about this problem, and it would be helpful if POPULAR SCIENCE would call it to their attention.

DONALD WILLIAMSON, Miami, Fla.

Additional canoe tips

I recently read "Canoe Camping—Rich Adventure on a Budget" [May]. However, you left out a few important items for the beginner. First, you should plan on getting wet. All clothing and equipment should be waterproofed, even if only in a large plastic trash bag. If you plan a long trip, it would be helpful to take a course in basic canoeing from the Red Cross or the YMCA. Knowledge of lifesaving is helpful.

Above all, for sheer safety, on a person's first trip he should go with an experienced canoer. All the fancy equipment and safety gadgets won't help if you can't "read the river." And that comes from experience.

R. LAWSON FOWBLE, JR., Lutherville, Md.

Pool-price error

"PS Buyer's Guide to Above-Ground Pools" [Apr.] was very informative and should create interest in the swimming pool industry. The prices listed for our pools are those to dealers, who buy in considerable quantity. They are not consumer prices. For exact prices, readers should contact their nearest Muskin Pools dealer.

RON GALLO, Muskin Corp., Wilkes-Barre, Pa.

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017

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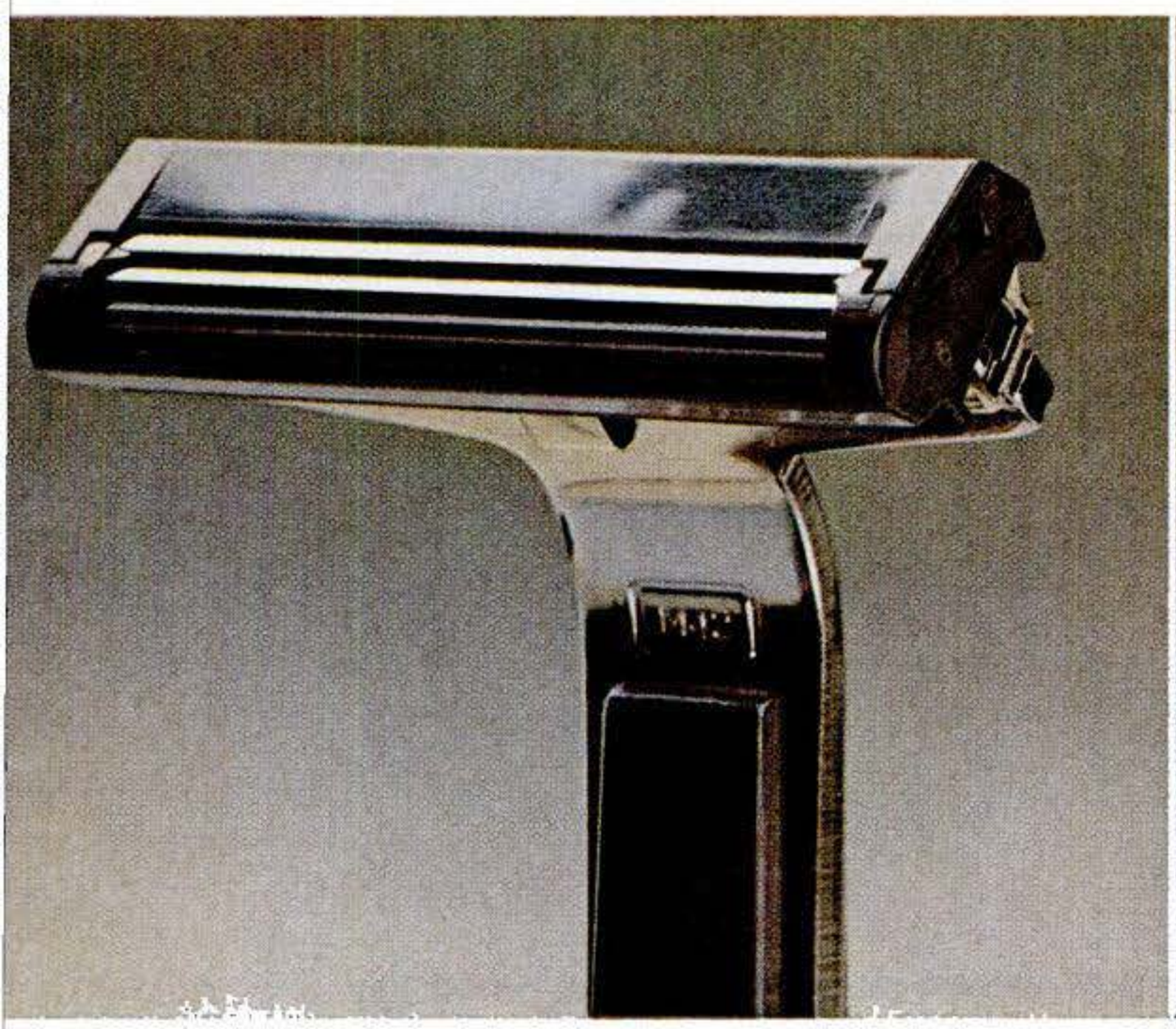
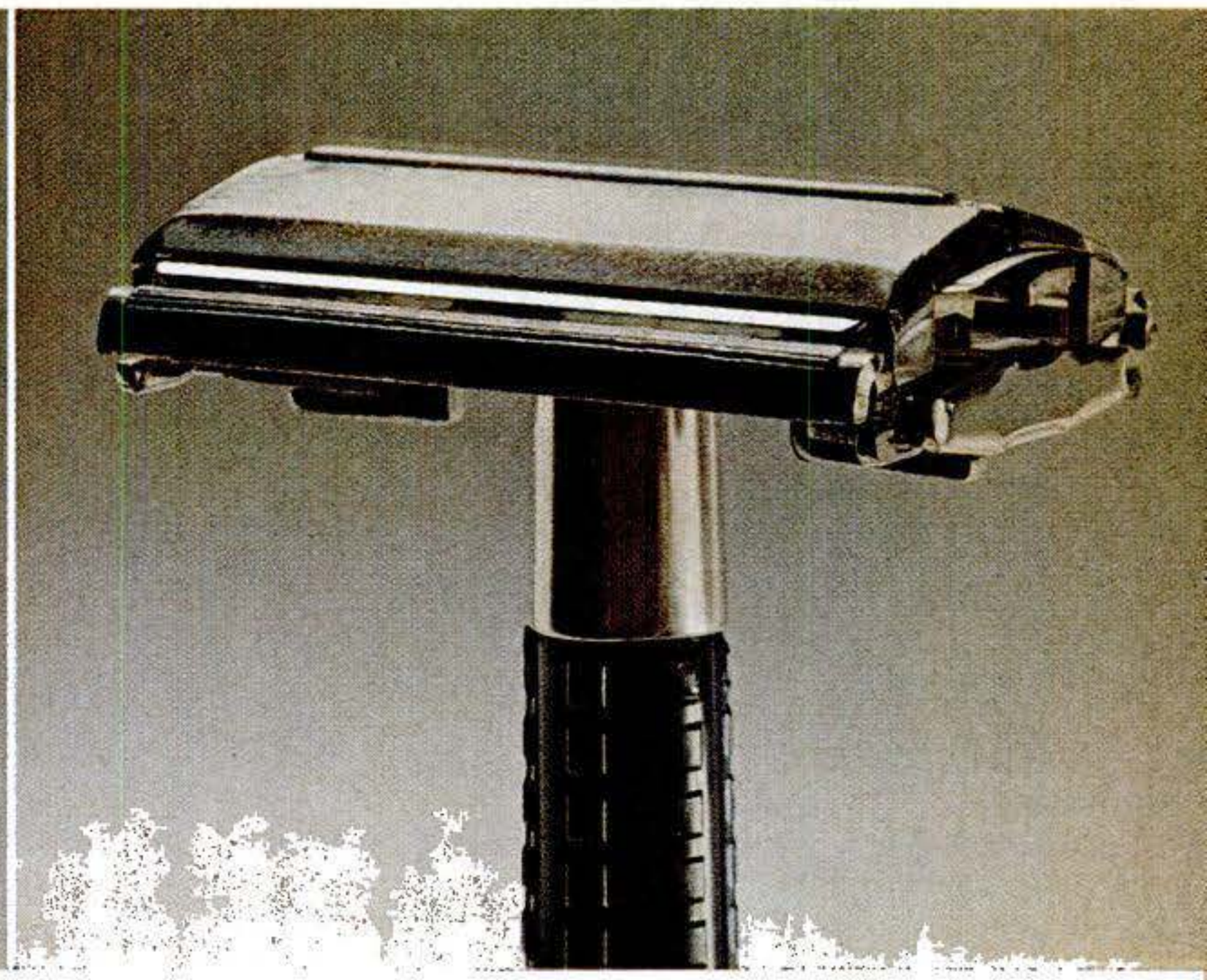
Schick Super II against I.





How double is a double edge razor, really?

There's never more than one edge working for you. While the other one's out there goofing off.

Now compare with the Schick Super II:

Both edges are on your side. Always working together.

The first edge shaves you close like your double edge now. The second edge shaves you closer.

There's really no comparison.

It's two against one.
Unfair maybe. But that's life.

The Schick Super II. Put both edges on your side.

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Let's talk about pollutants and car performance

We say just about every gasoline additive is worth the money.

But let's talk about our own. Marvel Mystery Oil. We've conducted an independent lab test that proves Marvel Mystery Oil cuts pollution when added to gasoline in old and new cars. It reinforces lubrication in upper cylinder areas where heat can reach blistering temperatures. And lubrication lasts after combustion is over.

Marvel Mystery Oil. More complete combustion. A cleaner engine. Longer plug life. Better performance. And more mpg. Test data on request.

Ask for other Marvel car care products too.

The "today" additive in a 50-year-old can.

Marvel Oil Company, Inc.
Port Chester, N.Y. 10573

Arrows point out IBM lift-off tape (above), correcting key (below, right).

This Typewriter Has a Built-In Eraser

One error every 100 words is supposed to be par for a good typist. In a working day, it adds up to a lot of erasing and retyping. Imagine how much time would be saved with a self-correcting typewriter.

I'm using such a machine right now: the new, $620 IBM Correcting Selectric. Basically, it's a Selectric II, latest version of the electric typewriter with a moving-ball typing element instead of a moving carriage. In the correcting model, below the right-hand shift key is an additional key marked X. This is the correcting key.

IBM's recently developed correctable film ribbon and lift-off tape are used in the Correcting Selectric. This ribbon produces a permanent nonsmudging imprint that can be removed instantly by retyping the incorrect character on the pressure-sensitive adhesive lift-off tape.

To correct your errors, you backspace to the last incorrect character by pressing the correcting key. This activates the correction process in the machine through a mechanical linkage. The film ribbon is locked down and, when the incorrectly typed character is restruck, the lift-off tape rises into printing position to make the deletion. The typing element remains in position to type the correct character. Repeat the procedure leftward until all mistakes on that line are corrected.—*Paul Wahl*

Three photos show how it works: first, the error (top); second, the original after correcting key is depressed; and third, after correction is typed in.

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Government report proves Datsun saves.

The government's Environmental Protection Agency has run gas mileage tests on all domestic and imported cars sold in the U.S. The tests simulated typical urban driving, and the Datsun 1200 delivered the highest mileage of all.

To dramatize this economy, we drove a Datsun 1200 from Los Angeles to New York. We say the car gets around 30 miles per gallon, but in this case we were wrong. Without special tuning or special equipment, we got nearly 38. We spent less than $30 for gas, coast to coast!

With the energy crisis making headlines every day, good gas mileage is more important than ever. That's why the Datsun 1200 makes so much good sense. It's the best way we know to save money without giving up the fun of driving!

DATSUN SAVES

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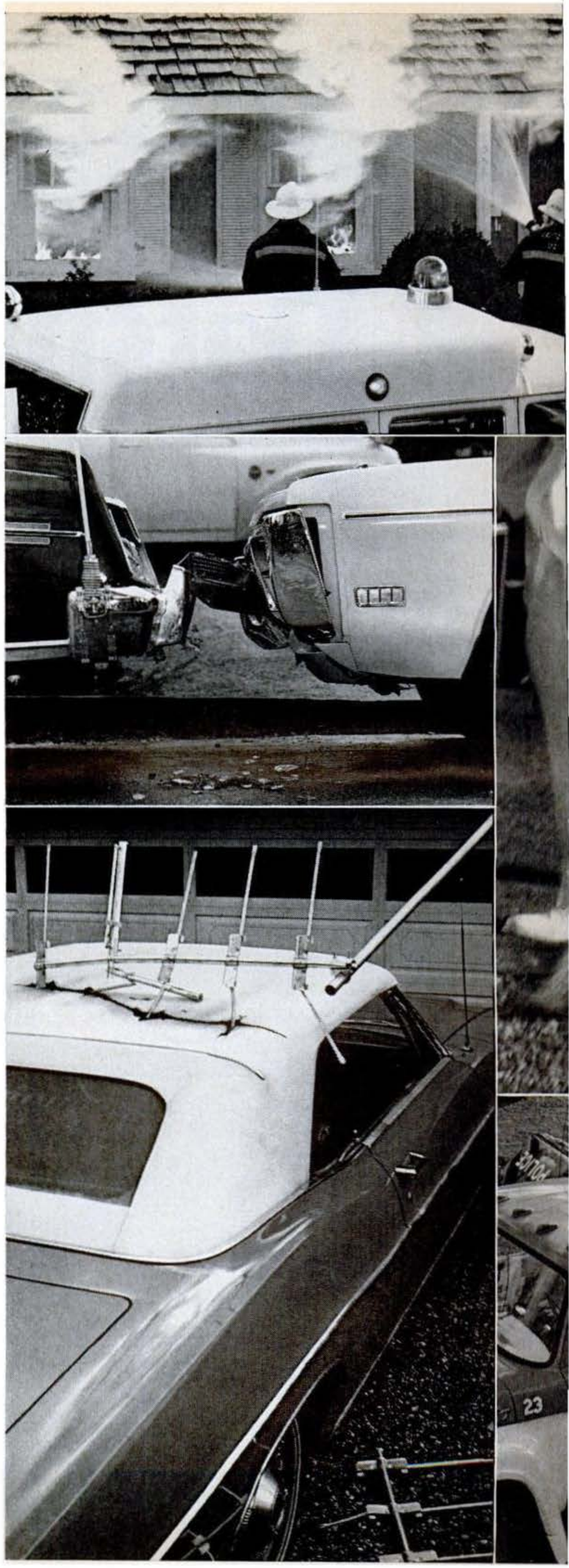
Finally. All the things covered in your separate home and auto policies can be covered in one policy.



Now you no longer have to have separate home and auto insurance policies to cover your home and auto.

Continental Insurance introduces the combined home and auto policy.

We call it the Personal Comprehensive Protection plan: PCP.

It's so comprehensive, you can even include hospital, disability income, and mortgage life insurance.

By combining several policies, it actually gives you more insurance coverage for your insurance dollar.

Combined Liability Coverage.

With separate home and auto policies, you have separate limits of liability coverage.

(For example, let's say your homeowners coverage has a limit of $50,000 and your automobile coverage has a limit of $100,000.)

With PCP, you have a single limit for both your homeowners coverage and your automobile coverage.

(You choose whatever amount you feel you need: $50,000. $100,000. $200,000. Or more.)

Now if you're sued—whether because of an auto accident or a home accident—you're protected by the new single limit.

Combined Home and Personal Property Coverage.

With a homeowners policy, you have separate limits of coverage for your home and your personal property.

If a loss occurs, and it's more than one of these limits, you can't use the other limit. Even if it isn't used up.

With PCP, you don't have to worry about separate limits on your home and your personal property.

You have one overall amount of insurance. And it's your limit, whether you have a loss on your home, personal property, or other covered items.

Inflation Protection.

Each year, inflation increases the value of your home.

So we automatically increase the amount of

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your insurance coverage based on one of the most accurate measures available: the U.S. Commerce Department's Construction Cost Index.

In addition, your home is covered on a *replacement cost* basis.

We don't deduct depreciation if your home is damaged, or if you have a loss on your household furnishings that exceeds $2,000.

Easy to Convert to PCP.

You don't have to cancel your present policies.

Simply join Continental's PCP plan and let your old policies expire.

We'll credit your PCP premium accordingly.

Guaranteed Renewal.

After 60 days, we guarantee annual renewal of your property and liability coverages at then existing rates for 5 years—unless any one of the following occurs: you don't pay the premiums; you sell your home; a member of your household has his driver's license revoked.

One Plan, One Man.

To cover everything you see here (and more) in one plan, call your Continental Insurance Agent.

(You'll find him in the Yellow Pages.)

Tell him that starting today you don't want to carry a lot of different policies with a lot of different companies with a lot of different premiums and a lot of different expiration dates.

Instead, you want everything rolled into one.

The Continental Insurance Companies

Home Office: 80 Maiden Lane, New York, New York 10038

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"Say, Smokey-"

A clinic on cars by America's most famous mechanic

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 355 Lexington Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

Coil wire burned

When my car stalled recently, I checked the distributor cap for condensation. There was no moisture, but I noted the coil wire pulled out easily, and on inspection, found that the end of the wire had burned off. It was quite a job taking the metal part out of the top of the coil. I put a new wire in and the car started without any trouble. What caused the wire to burn?

J. L. SPICOLA, Providence, R.I.

You didn't say what kind of wire you have, but I'm guessing it was a graphited-rope deal with a short piece of wire in the ends, because I've never seen a complete metal-core wire do this. But if the graphited-rope wire isn't handled correctly, the end will pull out, causing the spark to jump, and this will burn it up. You should have the standard end to fit in the coil.

Keeping ignition switch on

After reading "That Versatile VOM—Now It Troubleshoots Your Car" [PS, June '72], I bought one. Already it's proved out by locating a faulty spark-plug wire. When making primary-ignition-circuit tests, with the engine stopped, what is the maximum time you can leave the ignition switch on without damaging the "running resistance wire" on the coil?

ART HENDRICKS, Wantagh, N.Y.

I don't believe there is a great deal of danger, because many times the ignition is left on by accident until the battery is dead, with no major problem. But I don't like to leave it on over two to three minutes while I fish around. As you point out, things start getting warm when you leave the ignition on without the engine running.

Wailing-starter mystery

The starter on my 1969 Cadillac wails like a banshee whenever the engine is started. This condition was not present before the brushes on the starter motor were changed. The mechanic tried tightening the bolts and then backing off a half-turn, and then activating the starter to move the pinion gear into the flywheel gear. Then he retightened the bolts. However, the noise still persists and now he wants to take down the pan to get at the flywheel for a look-see. Would appreciate your ideas.

ERNEST PURNELL, Brooklyn, N.Y.

I'd have the starter removed, then backtrack the work that was done. Check especially for a spacer washer left out. I'm sure you'll find an error in assembly. I'd also examine the flywheel ring gear. If the mesh was improper—and it must have been to be noisy—maybe some damage has occurred. Everybody makes a mistake once in a while.

Poor-mileage overhaul

We have a 1964 Plymouth Slant Six with one-barrel Holley carburetor. At 72,000 miles the engine was overhauled and since then gets only nine mpg. We've taken it back to the shop, had the carb overhauled and adjusted, and a tune-up, and everybody is baffled by the poor mileage. Before the overhaul it got 20 mpg. Any suggestions?

GREG YORK, St. Joseph, Mo.

First have the engine checked for compression by the blow-down method. The leakdown should be no more than 10 percent on a warm engine. Assuming you find compression okay, I think you'll find the cam shaft and ignition-timing cam worn. Late or early timing would raise hell with mileage. Have the exhaust gases analyzed to see if the engine is too rich. Maybe you've changed the fuel pump and now are too high on fuel pressure. Also check the carb air filter to see that it is clean and unrestricted. One more thing: If the engine is extra tight, mileage would be bad.

Trailer-wheel toe-in

Please explain the proper wheel alignment for a utility-trailer axle. I've built several units with 0 toe-in and 0 camber and if they pulled any better they'd take off by themselves. However, several people have since told me that I should have 1/16-in. toe-in, but none of them explained why that is so. What do you say?

A. E. BEVIS, Charleston, S.C.

Toe-in and toe-out are built-in corrections to take care of deflections and absorb tolerances that have stacked up. Also they add some stability to a vehicle as the wheels are put in a slight bind, so they won't chase all over the road. I'd say this: If your trailer pulls good at 0-degrees toe-in, you should leave it as it is. If it tows well and doesn't eat up tires, you've made it right.

Replacing "oddball" V6

I would like to replace the "oddball" V6 in my 1962 GMC with a straight six or a small V8. I'm told only V6s were put into the '62 GMCs and that a changeover would involve many complications. Could you tell me if there are any engines that will replace the V6 (with three-speed manual transmission) and what problems would be involved?

ARTHUR A. BATES, Nacogdoches, Tex.

As far as I'm concerned, your "oddball" V6 is one of the best gasoline light-truck engines ever built. Our experience was that it had the longest life of anything we've seen. I recommend not changing it. Since you'll probably be unhappy with that answer: A small Chevy 327 or 350 will go in easily.

Oil pressure too low?

I have equipped my 1971 Chevy Caprice 400-c.i. engine with standard gauges—ammeter, water temperature and oil pressure—because I like to drive my cars 100-150 thousand miles, yet trade them in at top shape. I'm a little concerned about what my oil gauge tells me. I've calibrated it on a dead-weight tester, so I know it's accurate.

With the engine thoroughly warmed up, and at 70 mph, pressure is at 32-36 psi. According to Motor's Manual (my Chevrolet Shop Manuals give no figures) the pressure should be 35-45. How serious is this, and should I correct it? My pressure at idle is 12 psi. The car now has over 20,000 miles on it with no apparent trouble.

DON F. LEHMAN, Columbus, Ohio

Generally speaking, 10 lbs. of oil pressure at every 1000 rpm will handle the job just fine. That's with everything at normal operating temperature. Use that formula for a yardstick. I believe your engine is okay, although maybe at 70 mph the pressure may be a little low. The easiest way to up pressure is to put in a little higher rated pressure-relief spring in the oil pump (assuming again that everything is normal). I hope you're aware of the importance of frequent oil and filter changes for long engine life. Flushing the engine oil system once or twice a year is important, too. PS

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No Miracles Today!

Just a few ideas from AC that may help improve your gasoline mileage.

We don't claim to be miracle workers, but we have a few ideas that may help you improve your gasoline mileage.

First, check your driving habits. Don't practice jack-rabbit starts when the light turns green. Take off smoothly and drive at a steady pace. Avoid needless acceleration ... ..weaving in and out of traffic. Slow down before stopping; that'll help your brakes, too. And for sure don't drive at excessive speeds.

Second, make sure your engine is properly tuned. Remember, you can lose up to 12 percent gasoline efficiency when one spark plug in an eight-cylinder engine fails to fire. Intermittent missing and fouling also take their toll.

And third, whether you have your car tuned at your local service retailer or you tune it yourself, we would like to recommend AC Fire-Ring Spark Plugs. There's a set of ACs engineered to meet your car needs and driving conditions. Available most everywhere quality automotive parts are sold. We believe ACs will do a good job for you. We make them.

AC SPARK PLUG DIVISION

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The world's most popular pipe wrench. Known for the brutal punishment it takes and the long service it delivers. Here's why.

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PERSONAL-USE REPORT

Now You Can Mow with a Wankel!

Rotary engine in Arctic Enterprise's rotary mower, a first, offers smoothness, power, easy starting, and durability. Price? $160-$170.

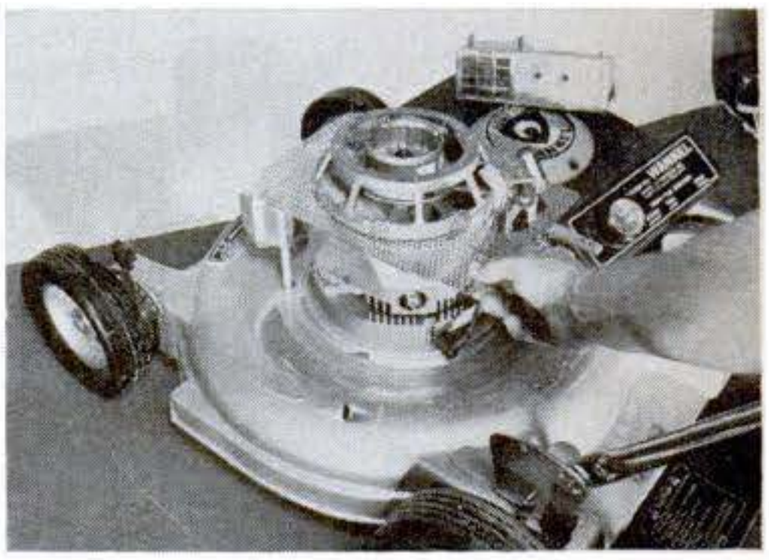
Want proof the Wankel's here to stay? Now you can put one to work mowing your lawn. I tried Arctic Enterprise's new 21-in., four-hp NSU-Wankel-powered rotary mower and I am impressed. The little engine never failed to start on the first or second pull; it waded through heavy growth and tough going with authority; the noise level was low, and, in fact, the whirr of the blade was more noticeable than engine noise. Above all, the general feel was one of smoothness and lack of vibration.

If you have misgivings about servicing a Wankel, don't worry. There's no difference. As with any engine subjected to the dirt and chaff of grass cutting, the air filter needs an occasional cleaning. You wash it out and put it back—nothing oddball here. The same goes for the screen that keeps the dirt out of the cooling fins. Carburetor and adjustments are normal. We didn't need to adjust it, however. Like to change the spark plug once a year? Go ahead—it's just like any other; gap .020 inch.

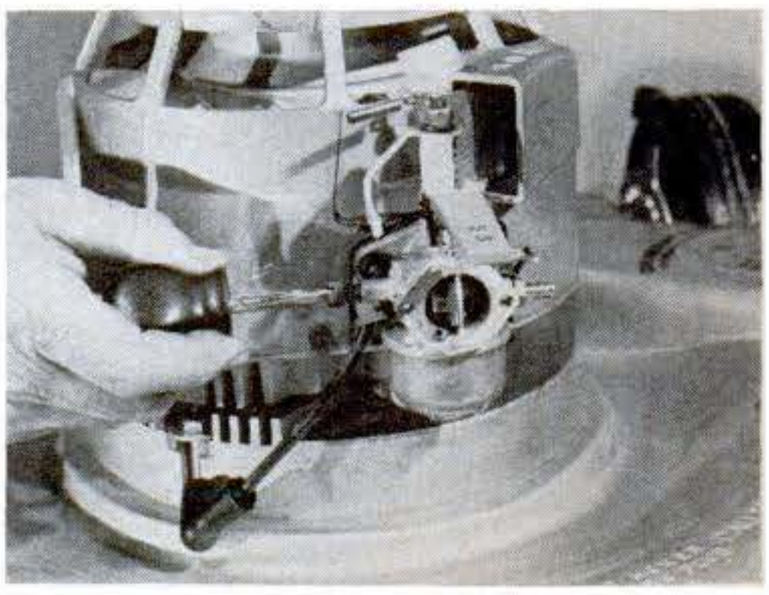
The Arctic NSU engine uses heavy-duty automotive oil mixed with regular gas. The instructions say 50:1, but we were told to use 25:1, then go to 50:1 after 300 hours —that's about 10 years of normal seasonal use. As there are no valves to burn out, my guess is that with normal care this is a lifetime engine.

The mower itself is a high-quality, cast-aluminum deck with sturdy wheels and a folding handle. This is not a lightweight unit and we'll bet that a self-propelled version will eventually be brought out. The maker is Arctic Enterprises, Inc., Thief River Falls, Minn.—*E. F. Lindsley*

Air-filter service is routine: Flip out grille, pull filter, and wash.



Screen protects cooling fins. Clean it occasionally. Four screws hold tank.



Carburetor adjusts like any other. Fuel inlet has filter screen—nothing novel.

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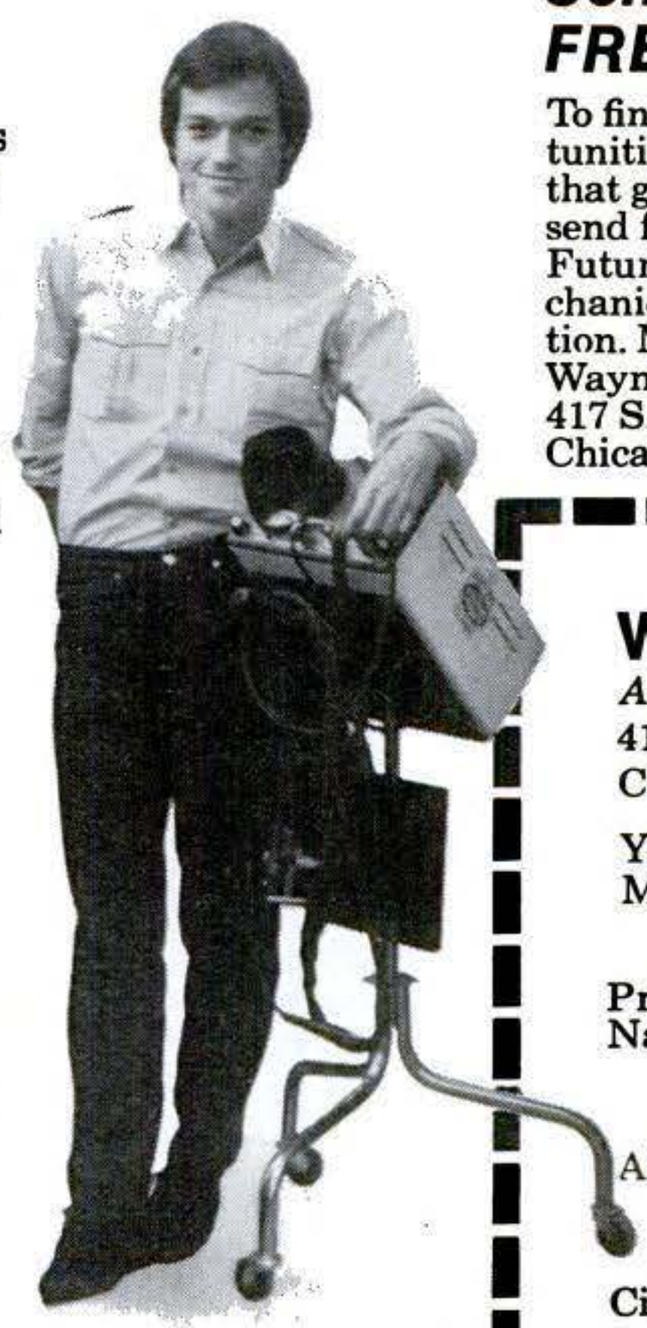
Do cars turn you on?

Then turn your hobby into a big-pay career . . . become an Auto Mechanic.

150,000 more trained auto mechanics are needed right now. And each year the demand increases. If you like cars, here's your opportunity to break into a big-money field where beginners are welcomed with open arms. Salaries are good. And with on-the-job experience your earnings will go up. Even back in 1969 the U.S. Department of Labor estimated average earnings of auto mechanics at $5.16 per hour! They're much higher today.

Prepare in your spare time.

Wayne can help you get started by training you right at home in your spare time. You keep your present job as you learn. We'll teach you all you need to know about motors, transmissions, brakes, fuel and ignition systems — how to service every vital part of a car. Our training is so up-to-date, it even includes instruction on the new Wankel rotary engine. Take this first step towards big earnings. Prepare now for an exciting career as an auto mechanic. Someday you might even want to open a profitable shop of your own. Free booklet tells how to get started. Send for it today. There's no obligation.



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Look and Listen

News, comment, and opinion from the world of home-entertainment electronics

By C. P. GILMORE

A good idea—and one whose time has come?

Maybe 1974 will be that year of the home video recorder we've all been predicting for a long time. I could get in trouble with such a statement, I know. I and a lot of others have been too optimistic in the past about when such machines would become generally available in American homes.

I can't say that my present opinion is based on anything very substantial, but there are indications that the companies that have to put up the millions to get these products on the market are getting more serious. In addition to the news items reported below there are more subtle hints here and there. The new Zenith annual report recently hit my desk, for example. And there on page three, right after the message to stockholders from President John J. Nevin and Chairman of the Board Joseph S. Wright, was a full-page picture of those gentlemen holding Zenith's experimental video-disc playback system. That picture wouldn't have been chosen for the key spot in the report if Zenith wasn't serious about video players. I have a feeling the field may be getting ready to move.

The film route?

You may remember learning exclusively in POPULAR SCIENCE back in December 1971 that Kodak had developed a film video player with some unusual features.

You could take super-8 movies of your son's birthday party, for example, slip them into a cassette, drop the cassette into the player, and see the celebration in color on your home TV screen. Kodak emphasized at the time it had no immediate plans to make the player. Now that's changed. The device will be on the market by the end of the year. It will cost about $1200.

That's just the beginning of the new interest in film players. Fuji Photo of Japan says it will be selling a similar unit in the U.S. about the same time. And a third firm—Cassette Sciences—says it has developed yet another film videoplayer that can handle either super-8 or 16mm film with either magnetic or optical sound (Kodak is magnetic; Fuji, optical) and it will cost just $495.

Furthermore, the company says it has already sold 12,000 of the new machines to an outfit called Cassette Television of South Africa. There is no broadcast TV in South Africa; it's scheduled to begin in '75 and will be only on a part-time basis then. But the TV-set makers want to begin selling to South Africans now. So Cassette Sciences expects to sell its film video players so that people who buy TV sets before broadcasting begins will have something to play on their new sets.

Cassette Sciences promises to have a public demonstration of the device in New York soon. I'll be there and will report back to you.

New from Cartrivision

Sears, Montgomery Ward, Admiral, and Teledyne Packard Bell have been selling magnetic-tape cassette video players for over a year now, and they all have a couple of things in common. First, all the sets on the market have been combination units, containing the record/playback deck along with a complete color TV set. Second, all the decks were identical, manufactured by Cartrivision.

Now, Cartrivision has announced it will begin selling under its own name, and at the same time will bring out a playback-only deck that you can use with your own TV set. It will cost about $800 and be available late this summer. Before the end of the year, the company says, it will sell a combination playback/record deck for about $1000.

Cartridges by mail

Cartrivision is also taking another major step—prerecorded cartridges (feature movies, for example) have been hard to find in some places due to a shortage of distributors, so they'll soon be available by mail.

Cartrivision has been hit by the old chicken-and-egg situation: With only about 2500 playback units now in the hands of customers, it is having a hard time setting up a nationwide chain of distributors for prerecorded programs. And with so few places around most neighborhoods where tapes can be rented, the machines are hard to sell. By making the full Cartrivision catalog of several thousand titles available to everyone everywhere through the mails, the company hopes to break out of the circle.

The disc spins into view

The Teldec video disc ["Amazing Video Disc Plays Through Your TV," PS, Jan. '71], first of the disc players to be announced and demonstrated more than two years ago, is now going to market. The Teldec company, a joint venture of British Decca and Germany's Telefunken, says machines and discs will be on the market in Europe in January 1974, and in the U.S. a few months later. Cost of the player—a single-play, magazine-loading device—will be $700. And in honor of the event, the Teldec system has a new name. From now on you can call it TED.

On the road

You soon won't be able to rent a hotel room without being offered pay movies over your room's TV set. Computer Television, one of the companies in the field, has just signed with the Hilton chain to install the CIT movie system in 40,000 Hilton rooms across the country now, another 25,000 within a year.

The system will contain three channels, so you'll have your choice of that many simultaneously running movies; ultimately the systems can be expanded to six channels. Price per viewing hasn't been announced, but most hotels now offering the service pin about three bucks on your tab for each flick you watch.

TV on the wall

Remember the POPULAR SCIENCE cover story [PS, Sept. '72] about the Advent projection TV system that can spray a brilliant 10-square-foot picture on a screen on your living-room wall? Well, now it's available. Advent Corp. has begun selling the units in the Boston area (Advent is right across the Charles River in Cambridge) and will soon move to national distribution with a press demonstration in New York. Price remains at $2495, complete.

The four-channel battle

It reminds me of the big fight more than 20 years ago when CBS brought out the 33 1/3-rpm long-playing record, and RCA answered with its 45-rpm disc. Today's fight is over four-channel records, with CBS's SQ system squared off against the RCA-JVC four-channel discrete disc (the CD-4 system).

And the battle is warming up. "We believe the technical problems of achieving four-channel commercially viable discrete records are just about insuperable," says Walter Dean, executive v.p. of CBS Records, in effect writing off RCA's efforts. But RCA considers Dean's obituary for the four-channel discrete disc somewhat indiscrete. "It will be a discrete world by the end of this year," says Rocco Laginestra, president of RCA Records.

Continued

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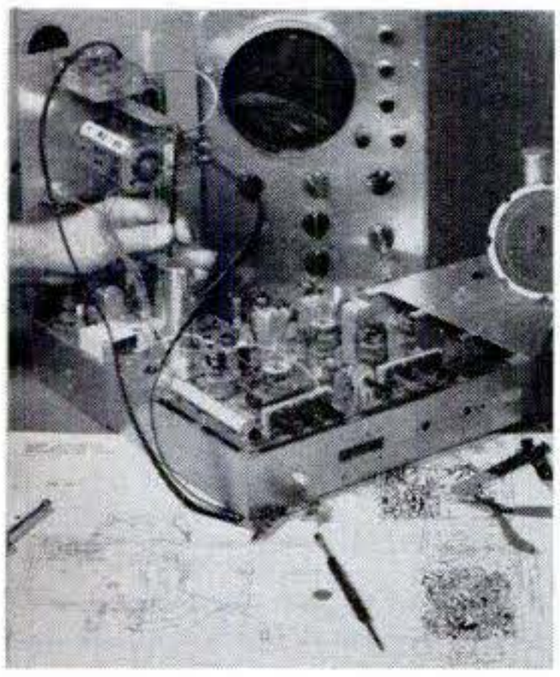
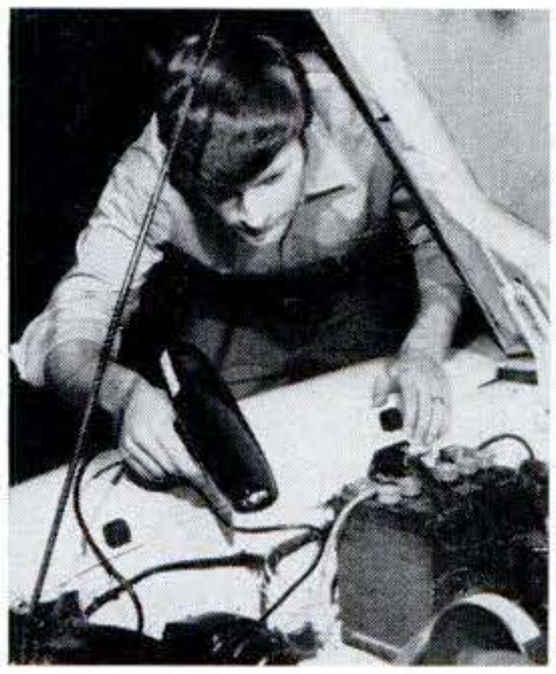
4 needed skills NRI can teach you at home

NRI courses can show you how to service TV-Radio, Repair Cars or Appliances or have a career in Air Conditioning, Refrigeration and Heating



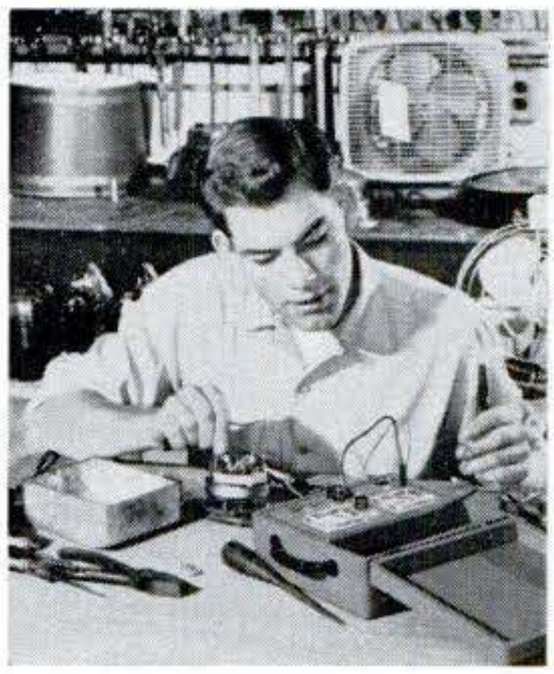
TV-Radio Servicing

The NRI TV-Radio Servicing course includes your choice of black and white or 25" diagonal solid state color TV training equipment. NRI courses cover FCC license preparation, complete communications electronics, aircraft electronics, mobile communications, marine electronics, amateur radio, industrial and computer electronics.



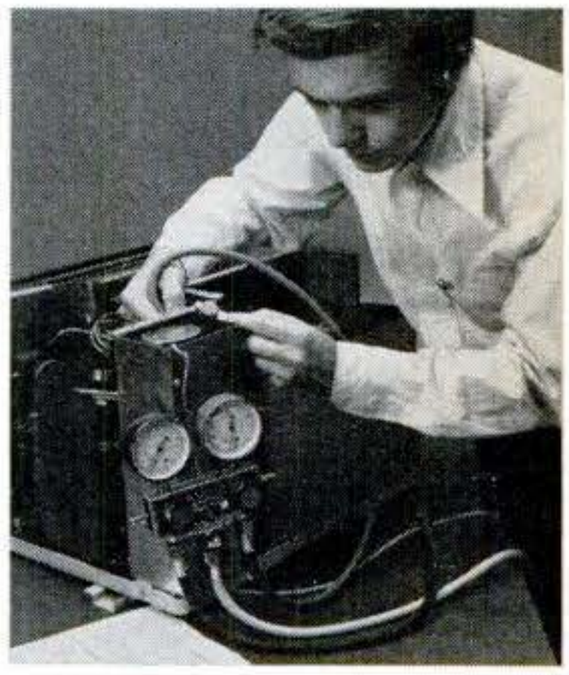
Automotive Repair

Take your choice of the Master Automotive Technician course or the shorter Automotive Tune-up and Electrical Systems course for the man seeking greater understanding of basic car repair. Both courses include professional equipment so that you get "hands-on" experience and the chance to earn spare-time money making repairs.



Appliance Repair

NRI trains you to fix all kinds of electrical appliances, plus washers, refrigerators, house wiring, electric motors, even small gas engines. Bite-size texts fully illustrate each point. An appliance tester is included for fast trouble-shooting, so you can begin earning money repairing appliances long before you finish the course.



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At the moment, CBS is out front with more records on the market and more equipment in the hands of the public, but RCA is catching up here and in Japan. The discrete disc got a big boost recently when the WEA Record Group, second biggest marketer in the country (Warner, Elektra, and Atlantic records), decided it would go the discrete RCA route.

The battle is being waged on the technical front, too. Both companies are known to be working feverishly to develop IC chips for their decoders so that playback equipment will become simpler, cheaper, and better. The outcome is certainly not clear now. While one side may eventually overpower the other, it seems more likely the two will coexist indefinitely.

Lending credibility to this view (despite all the rhetoric by company officials) is that both sides are taking back-door trips across the other's turf. Some leading CD-4 backers such as Panasonic and JVC, for example, are including SQ decoding circuitry in some of their new receivers. And Columbia is rumored to be buying some CD-4 mastering equipment. Columbia is apparently interested in the CD-4 equipment both to keep up with what is happening and to make records for some of its customers such as WEA, who will be issuing CD-4 records.

Reviews by Arthur Fisher

High-quality open-reel tape decks are acquired primarily because the owners make live and off-the-air recordings. But there is a dedicated minority of audiophiles who use these sophisticated machines for listening to prerecorded music, putting up with the unarguable clumsiness of open reel for the aural superiority of the best of such tapes over the best disc and cassette recordings.

If the gap between open reel and the other recorded media had been lessening recently (mostly because of dramatic improvements in cassette technology), it has just been firmly reestablished by two advances announced by Ampex.

The first is Ampex II, a basic improvement in all Ampex open-reel tape products from now on; the second, perhaps more significant, is the release of the first Dolby open-reel recordings.

To sample these tapes, I used a new version of a "semiprofessional" deck that has consistently earned high marks from recordists. This is the Revox A-77 Mark III, a quarter-track, two-speed stereo deck. Its new feature: built-in Dolby noise-suppression circuitry. (At this writing, only one other machine, the Ferrograph, has built-in Dolby.) Used purely as a playback device for this survey, the Revox handled and reproduced superbly, as indeed it should at its near-$1000 price. (Of course, you can play back the new Dolby tapes with a conventional open-reel deck and an outboard Dolby unit.)

Let's start with the Ampex II development. Ampex is using a new tape stock—lower noise and higher output than formerly. And, it has switched to new solid-state electronics in its tape-duplicating equipment, and a new noise-reduction system in the production of masters. The result is improved signal-to-noise ratio. I could hear the change easily by comparing a favorite showpiece—the London release of Respighi's *Pines of Rome* and *Fountains of Rome* conducted by Ernest Ansermet—in both old and Ampex II formats. There is simply no contest.

But the real revelation came when I threaded the new Dolby releases (which, naturally, have Ampex II processing) through the Revox. Talk about state of the art! The Dolby process rids open-reel tape of every vestige of dat 'ol debbil, hiss. The result—ultra-wide-range, ultra-clean, and, when there is no impressed signal, ultra-silent—must be heard to be believed.

I compared several of these new tapes with their previously released counterparts on Dolbyized cassettes. Holst's *The Planets* (London/Ampex) conducted by Zubin Mehta is a splendidly engineered cassette, with spectacular sound, an orchestral orgy for demonstration purposes. But the new open-reel version makes it pale—in a direct A-B comparison. It's more noise-free, more open.

The contrast was even more pronounced when I A-B'd Offenbach's *Tales of Hoffman* (London/Ampex) in its new open-reel and cassette versions—both Dolby. This recording has long stretches of unaccompanied dialogue; the greater naturalness of the voice in the reel version is most convincing.

When the comparison is between the new Dolby reel and a non-Dolbyized cassette, or the original disc release, the advantages of the new medium are naturally reinforced. Thus Smetana's *Ma Vlast* (Deutsche Grammophon/Ampex) conducted by Rafael Kubelik is sonically much superior in the new version.

Another DGG/Ampex Dolby reel demonstrates how much the sound of a solo instrument can be improved by totally suppressing background noise—Emil Gilels playing Beethoven's piano sonatas Op. 53 and 101.

Other notable recordings in this first batch of Dolby reels from Ampex: London's *Mahler Symphony No. 6,* with the Chicago Symphony conducted by Georg Solti—electrifying in engineering and performance; DGG's equally stunning *Three Places in New England* by Ives and *Sun-Treader* by Ruggles, with the Boston Symphony conducted by Michael Tilson Thomas. PS

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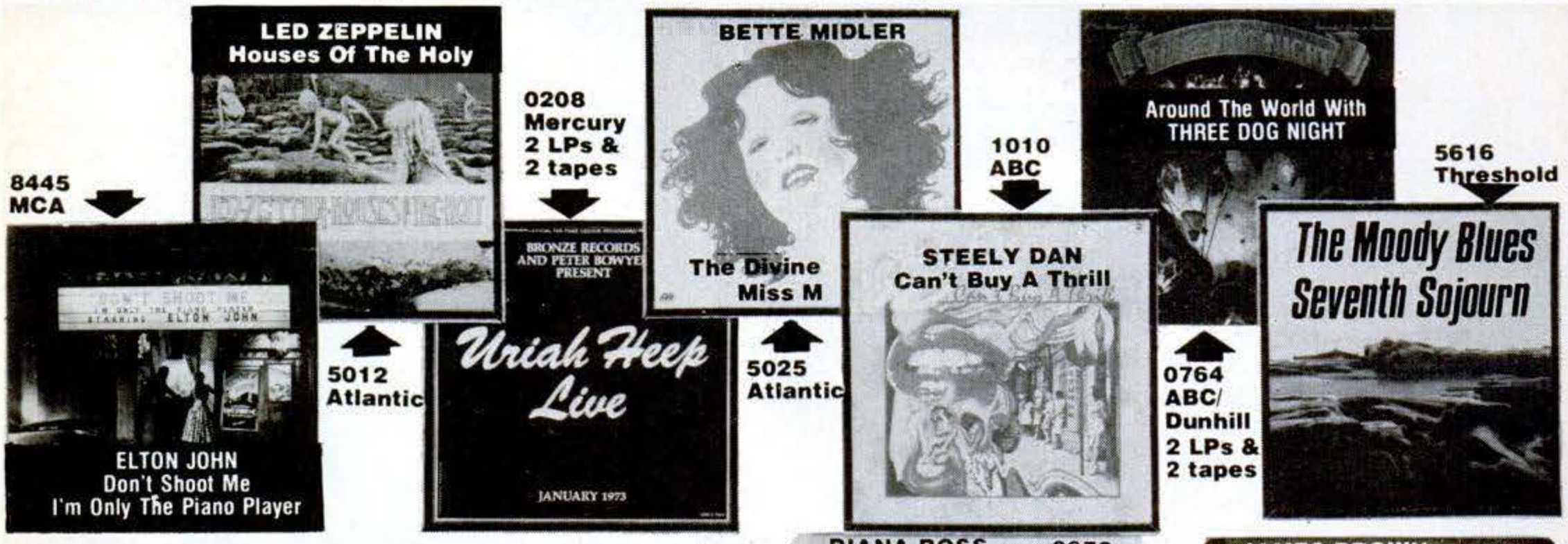

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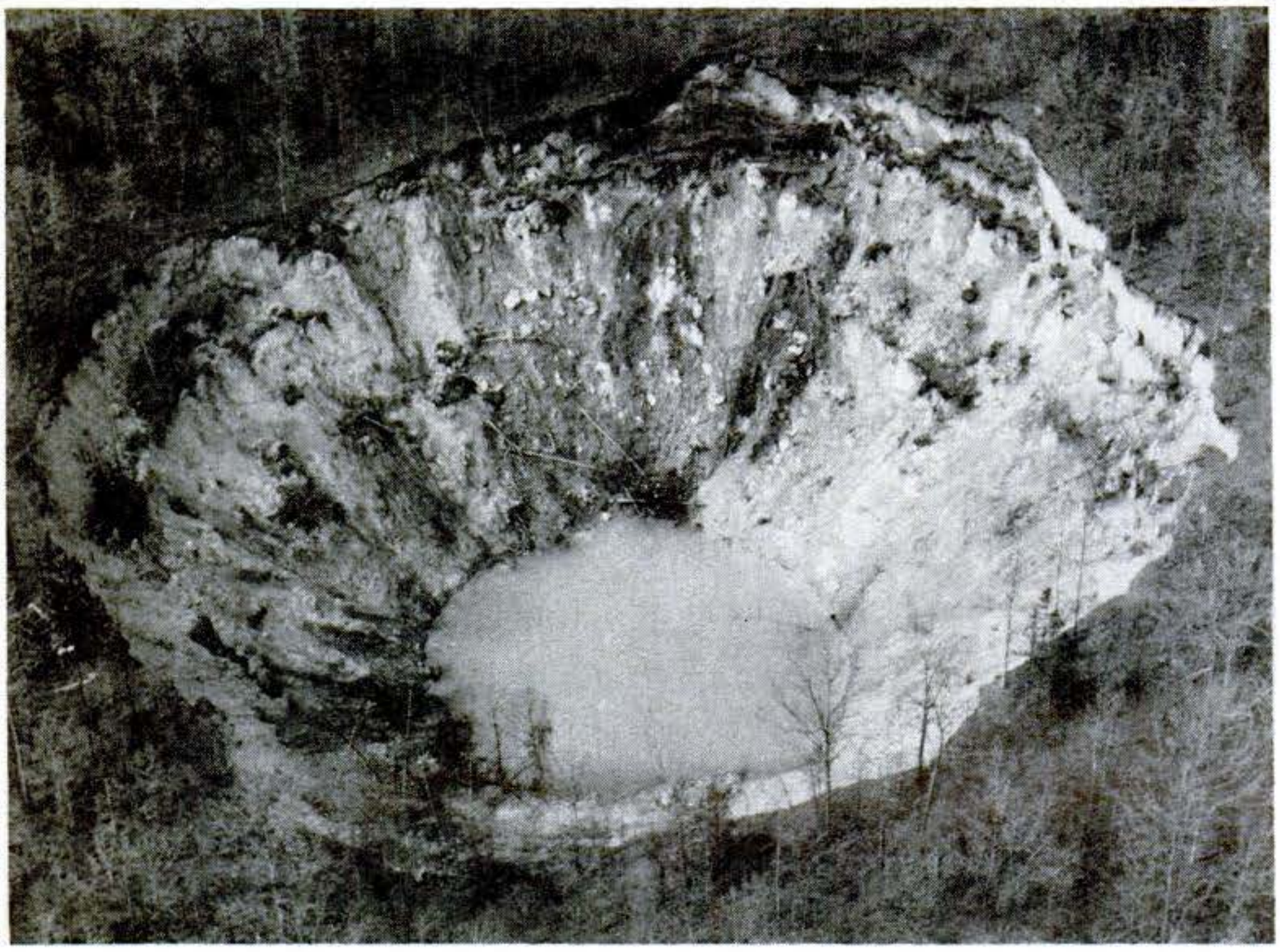
Science Newsfront

Last-minute news and notes to keep you up to date By ARTHUR FISHER



Going, going, gone—mystery of the "December Giant"

No, stars didn't fall on Alabama, though this certainly looks like a crater of some kind. It's actually a sinkhole, perhaps the largest in the country (425 feet long and 150 feet deep). It was born on December 2, 1972 (thus the name, "December Giant"), to the roar of plummeting boulders and the snapping of tree trunks, in Shelby County, Ala., an area that has been scarred with increasing numbers of the pits in recent years. Sinkholes usually occur where the ground is underlaid by limestone caverns. John G. Newton, a hydrologist with the U.S. Geological Survey, believes that the plague of holes in Alabama may be caused by man's lowering of the water table, inducing the collapse of limestone domes.

Cable TV via space

Pending approval by the Federal Communications Commission, TelePrompTer Corporation will use signals from Anik-I, the Canadian domestic satellite ["Communications Satellites," June PS] to test an experimental mobile Earth station that could be used as the link in a space-satellite/cable-TV network.

The receive-only station, shown here as a model, will be completely contained on a single tractor-trailer unit. The trailer will carry a demountable 25-foot-diameter receiving antenna and the necessary electronic equipment, together with heating and air-conditioning equipment, and will cost about $100,000.

If current plans hold, the mobile unit will first be used by the National Cable Television Association for an industry demonstration of satellite capabilities. Then it will tour the United States for 12-18 months for engineering tests at various locales. The aim of TelePrompTer, the country's largest cable-system operator with about 750,000 subscribers, is to make early use of a U. S. domestic communications satellite now scheduled for launch in 1974.

Watch those prints!

Felons have even more to fear from left-behind fingerprints now that the FBI is studying FINDER—a computerized fingerprint reading and identification system, developed by Calspan Corporation (formerly the famous Cornell Aeronautical Laboratory).

The prototype under evaluation by the FBI can "read" a fingerprint in half a second, processing the more than 500,000 resolution elements for each print that make it unique, such as where ridge lines—typically 0.008 inch wide—either end or split in Y-shaped branches. That rate makes FINDER the fastest digital image processor around. In the photo below, a Calspan researcher is comparing a test print, which appears enlarged on the screen, with the computer's analysis.

Calspan engineers foresee the application of FINDER's technology to other security uses, with a saving of billions of dollars now lost to forgers and thieves. The automated image-processing system could, for example, be used to verify signatures on checks and credit cards. It could also be developed into a kind of unmanned guard post, a personal-identification terminal, where a person could simply insert his finger into a small device that would "read" his print and match it against a set of authorized prints stored in its memory.

Bloodcell "factory"

A team of scientists at the Medical Research Center of the AEC's Brookhaven National Laboratory has achieved a significant first: Using a tiny diffusion chamber, it has

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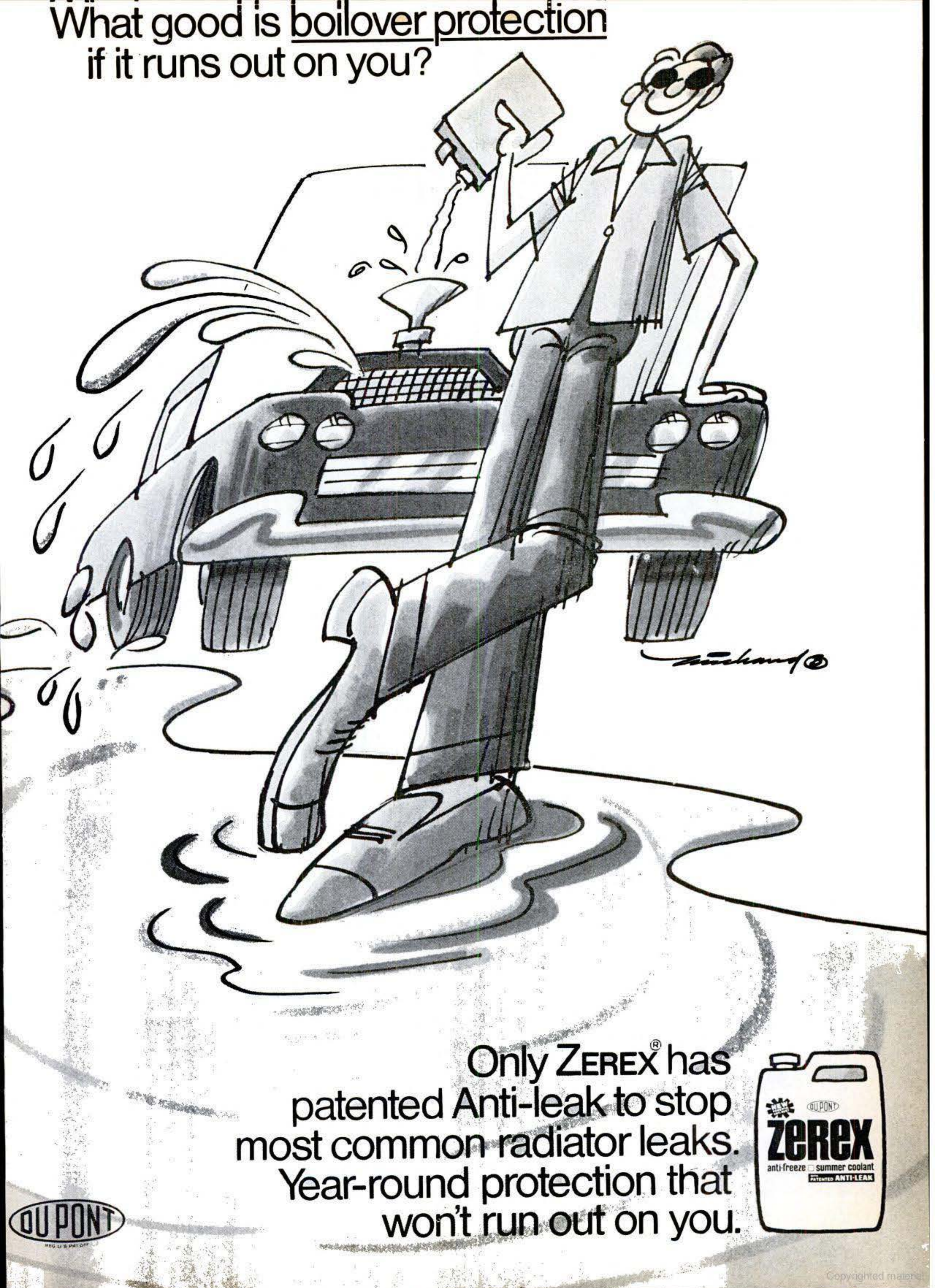

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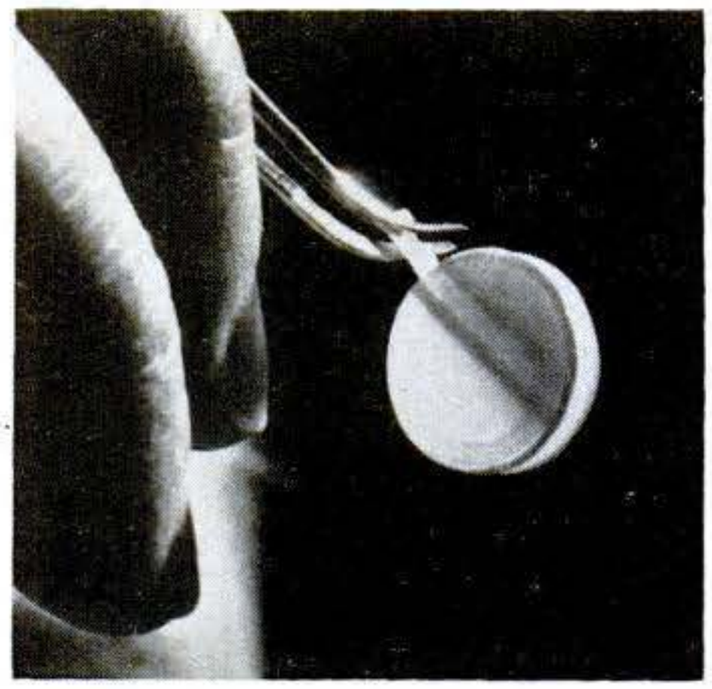
duplicated the living system of human blood-cell reproduction outside the human body.

The chamber, seen in the picture below, is a sandwich containing a plastic ring with a filter paper on each side. The filters pass fluids but not cells. Stem, or parent, cells from human bone marrow (where blood cells originate) are first placed in the hollow cavity of the ring. Then the whole chamber is



transplanted into the abdomen of a mouse, where it floats in a rich bath of nutrients.

The result is the reproduction of normal human blood cells, inside a living laboratory that can be manipulated in ways no human subjects could. The research could yield better understanding—and perhaps cures—of some blood diseases.

Earthquake prediction

There's earthshaking news in the air. American scientists have claimed they are developing a reliable method of predicting not only the time and place of many earthquakes, but also their severity. And soon after that announcement, Russian scientists said they *have* actually predicted three mild quakes.

Dr. James Whitcomb of Caltech reported to the American Geophysical Union that the technique that he and his colleagues are developing depends on the measurement of changes in the compressibility of underground rock before a quake.

The more severe an impending quake, the earlier these changes become apparent, so that it might be possible to anticipate a small quake a few days in advance, whereas a really big one, like the San Fernando shock that tipped 6.4 on the Richter scale, might give warning some 3½ years before it rumbled by.

Meanwhile, I. L. Nersevov, of Moscow's Institute of Earth Physics, said that Russian scientists had been successful in predicting three mild quakes two weeks in advance.

He said they were able to specify when and where the quakes would occur—but not how big they might be—on the basis of clues different from those the Americans are pursuing. One quake was tipped off by changes in electrical conductivity in rocks, the other two by an increase in the amount of radon, a radioactive gas, in well water.

Heat into electricity

A new kind of thermoelectric generator is being built by scientists at Ford Motor Co. Derived from Ford's research on a sodium sulfur battery, the new device relies on an external heat source and converts heat energy directly into electricity, without moving parts. Previous experimental direct thermoelectric generators proved impractical. But Ford researchers believe their new concept may allow the use of large-scale devices for supplying energy.

The generator works like this: Sodium is heated externally. The hot liquid sodium releases electrons, and passes, in ionized form, through a special, electrically conductive ceramic material called beta-alumina. Released electrons circulate through an electrical circuit to do work, then recombine with the sodium ions that have passed through the beta-alumina. The sodium is then condensed, reheated, and recirculated to the hot liquid-sodium side of the generator. The sodium moves through the various stages because of pressure differentials.

Dr. Terry Cole of Ford thinks one possible use is powering remote weather stations using radio transmitters, but also foresees the generator's use in homes, industry, and campers. One intriguing suggestion is to use the liquid sodium that is circulated as a cooling agent in some nuclear reactors. By the end of the year, Ford expects to have a less-than-10-lb., 10-watt generator.

Ring around the rings?

Surprises from Saturn:

First, two Jet Propulsion Laboratory radar astronomers succeeded in probing the planet with radar. The result, according to Dr. Richard M. Goldstein and George A. Morris Jr.: "We received much stronger bounceback signals than we expected . . . the rings can not be made up of tiny ice crystals, dust, or gas. Our echoes indicate rough, jagged surfaces with solid material one meter in diameter or larger. Possibly much larger . . . must be considered an extreme hazard to any spacecraft sent into or near the rings."

Next, two Cornell University electrical engineers, Thomas R. McDonough and Neil M. Brice, predicted that spacecraft will find Saturn and its visible rings surrounded by a giant, invisible ring shaped like a squashed doughnut and made of hydrogen atoms. Source: the leaking atmosphere of Titan, one of Saturn's 10 moons. PS

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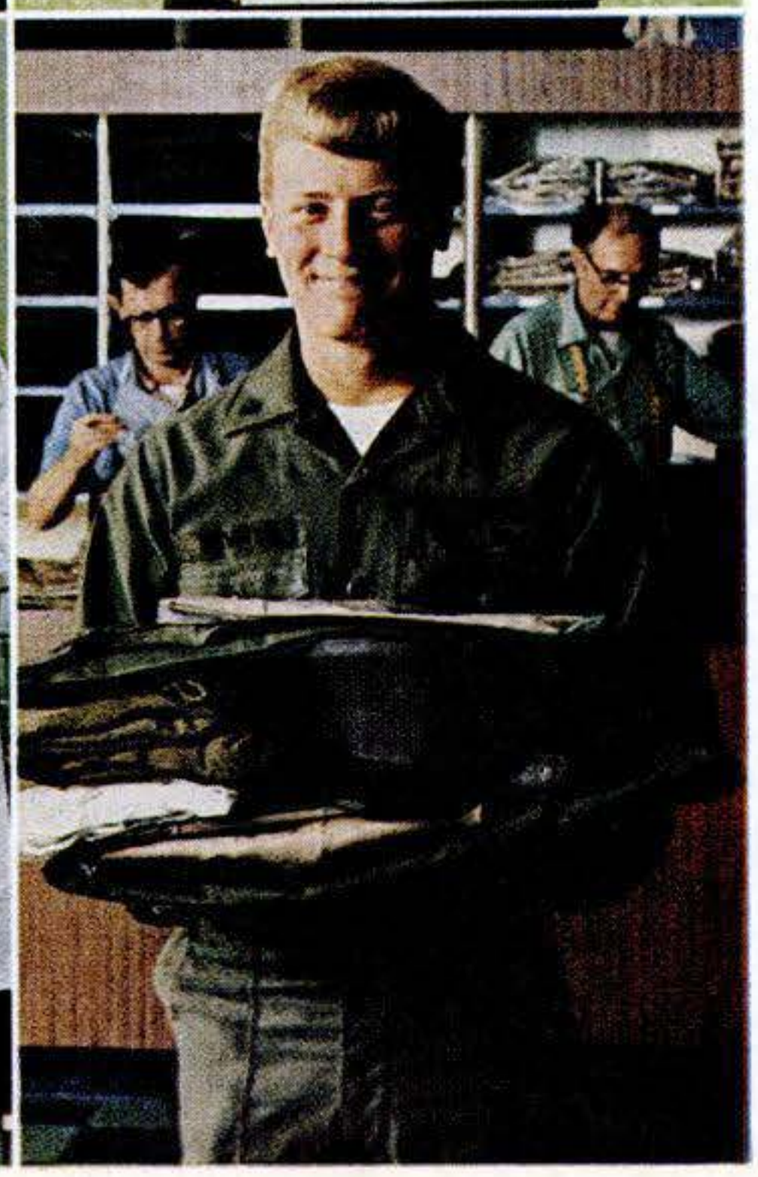

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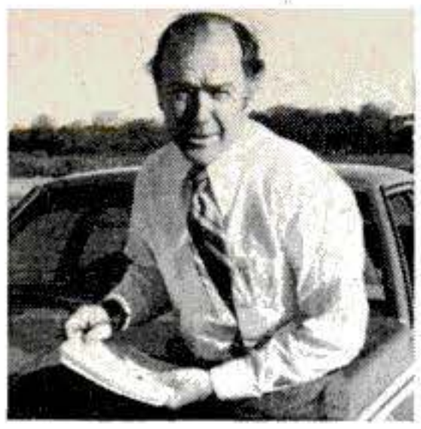

Detroit Report

Behind the scenes in the auto industry

By JIM DUNNE / *PS Detroit Editor*

Small-car revolution continues at American Motors

Even today, they can't make enough Hornet Hatchbacks and Gremlin Xs to satisfy the demand. But American Motors is not yet through with its small-car revolution. It plans to bring out a super-sporty car in 1976, and keep it down to just about the same size as the Gremlin. This car will be the production version in the Amigo program started two years ago, with a rotary engine in mind. AMC now has a Wankel license, but the new model will initially have a conventional engine. The rotary may be added as an option after a year or two on the market. The car will be equipped with a plush interior, air conditioning, full instrumentation, vinyl roof, and radial-ply tires as standard. AMC market studies show more people will turn to small cars if they don't have to give up any of the big-car luxuries.

Square headlights coming

Headlights have remained largely unchanged for 35 years, but now auto stylists are itching to introduce new shapes. By law, the round headlight is standard on cars sold in the U.S. Sizes, candlepower, color, and shape are set by government standards patterned after regulations agreed upon before WWII.

But small round headlights aren't the most efficient. Bigger reflectors, more candlepower, and different lens shapes make for better illumination, say experts. Headlights are overdue for a big change, and the government now seems willing to listen to proposals. One, from GM's Guide Lamp Division, would put rectangular lenses over lamps of 1975-'76 cars. Westinghouse proposes a three-lamp system—an adaptation of the present quadra-headlight setup. It has an intermediate setting for conditions requiring light levels between high and low beam.

Imperial back on top

Chrysler will finally do exactly what has been rumored for a long time: bring the Imperial back into the regular Chrysler lineup as the top-of-the-line model.

Wheelbase, front and rear track, and other dimensions on '74 Imperials will be identical to less-expensive Chryslers. The Imperial will have special features setting it apart from the rest of the line: four-wheel disk brakes (the first U.S. passenger sedan so equipped) and radial tires (standard for the first time on a Chrysler product).

Luxury cars without seatbelts

That's the way GM's air-bag program is working out. GM will build 100,000 cars with the controversial air-bag system in 1974, about half Cadillacs, the rest Olds 98s and Buick 225s. That means only luxury-car buyers will have air bags. Other 1974 buyers will have to put up with the ignition-interlock seatbelt system. When air bags are installed—as an extra-cost option—safety belts are not required for front-seat occupants. Padded car interiors, coupled with air-bag action—inflation in 12-mph or faster crashes—provide all the protection occupants need. That means luxury-car buyers need not pause to buckle up.

The meter inches in

General Motors now has a formal program converting its products to the metric system, while Ford moves in the same direction on a different route. GM will immediately convert all new developments to the metric system. This includes items now in the development stage, such as Chevrolet's rotary engine. Service parts will not be changed until the program is completed—you can still buy replacement and maintenance items with nonmetric measurements. GM suppliers must also build newly designed parts to metric specs.

Ford, meanwhile, is preparing Mustangs with engines built to metric dimensions. Both the V6 imported from Germany and the 2300cc four-cylinder to be built in the U.S. employ metric measurements. Complete changeover? At least a decade.

Beat the fuel crisis

One way to sidestep gasoline shortages and rising costs is to increase your car's fuel economy. The spread between cars is enormous—as low as eight mpg on some luxury sedans to as high as 32 mpg on smaller, less-powerful vehicles.

Folks at Shell Oil's Wood River (Ill.) plant may be on the right track. They make a science of fuel economy, and get incredible mileage from every drop of gasoline. Their annual mileage contest last year produced a high of almost 300 mpg in the winning Opel. A 250-mpg Fiat made second place.

Special driving techniques used by these experts include accelerating and shutting off the motor repeatedly, inflating bald tires to high pressures, and free-wheeling. Not all the cars are tricked up. Standard sedans, driven at normal speeds over hilly, twisting public roads recorded 34 to 44 mpg. Nothing you can't copy here. Highly tuned engines and skillful driving are the rules contestants follow.

Cougar changing its spots

Two changes are planned for Mercury's Cougar line. The '74 Cougar will become a Montego-line model, a change dictated by the Mustang's switch to a new body. Since Mustang and Cougar are built on the same body, Cougar was forced to some kind of change for 1974. L-M officials decided to make it bigger, not follow Mustang to a smaller size.

In late '75, Cougar will become a unique model in the company's lineup when Ford changes the Maverick's body shape. At that time Cougar will get a stretched version of the Maverick's basic body. The Cougar will have sheet metal and trim to set it apart as a personal luxury car, something like Pontiac's Grand Prix.

Government spurs innovation

Would recent progress in bumper design have occurred without the five-mph standards forcing changes? New plastic front ends—like those on the Grand Am and Laguna—certainly wouldn't be necessary except for that government prodding.

Now Camaro and Vega are switching to aluminum bumpers for '74, a first for U.S.-built cars. The future holds more of the same, according to GM designers. Aluminum's light weight plus its extrudability, make it ideal for today's smaller cars.

High-performance six

Ford is apparently taking a big chance by making the V6 its top power plant in the '74 Mustang. Most performance-car buyers look for a V8 under the hood, and will wonder about the power the V6 will deliver.

Ford's decision appears to be sound, however. The 2800cc engine is similar to but bigger than the one used in Capris. Acceleration times for that model are very respectable: zero-to-60 mph under 10 seconds. While the car won't be an all-out muscle performer, it will have the power most sports-car buyers expect in a small car. PS

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Can you spot the Camel Filters smoker?

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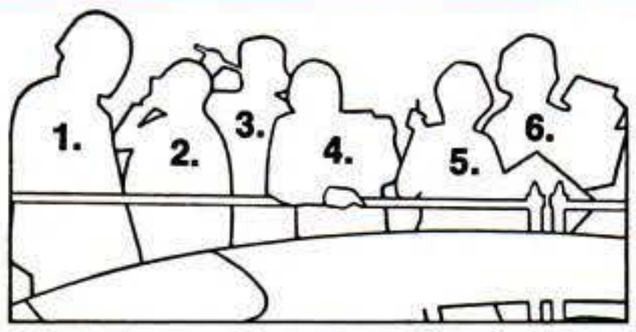
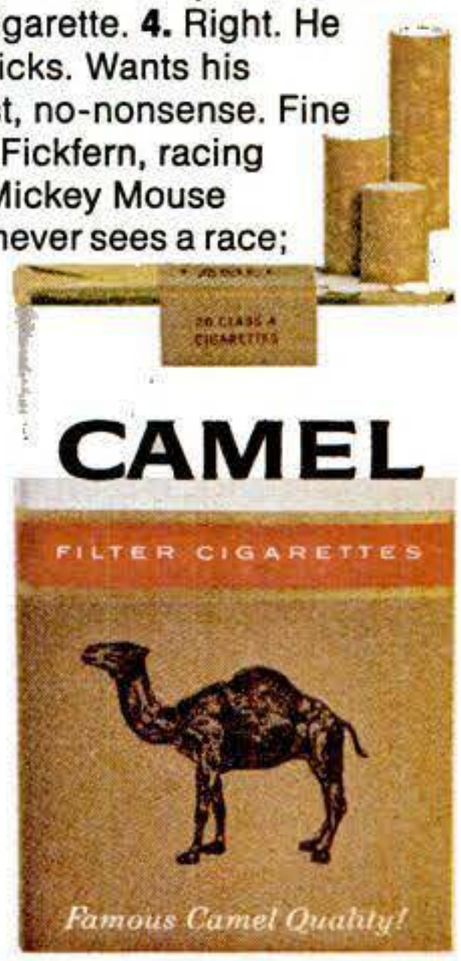


Here at the Speedway everybody has a gimmick . . . almost everybody. Try picking the one who doesn't go along.

1. Nope. He's "Third Turn" Abanian. Has been in 263 races. Gimmick: always loses control on third turn where Bubbles Fickfern stands (see #5 below). He doesn't smoke. His car does. **2.** No. Second-Hand Sam Slick, used car dealer. Gimmick: buys what's left of Abanian's cars. Smokes "pre-owned" cigars. **3.** Hardly. He's Reggie J. Van Phynque II. Gimmick: filthy rich. Wears cashmere toupee. Smokes double-vented cigarette. **4.** Right. He likes his racing without far-out fads or gimmicks. Wants his cigarette that way, too. Camel Filters. Honest, no-nonsense. Fine tobacco. Easy and good tasting. **5.** Bubbles Fickfern, racing groupie. Gimmick: 18 stopwatches . . . with Mickey Mouse hands. Smokes Fellinis. **6.** Fellini. Gimmick: never sees a race; too busy following other sports events on portable TV and radio.



Camel Filters. They're not for everybody (but they could be for you).

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

20 mg. "tar," 1.3 mg. nicotine av. per cigarette, FTC Report FEB.'73.

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The View Down the Road

. . . news and comments on cars and driving

By JAN P. NORBYE / *PS Automotive Editor*

What really happened to the '75 emission standards

Last April 11, the Environmental Protection Agency granted auto makers a 12-month extension on the '75 standards. The problem is that the battle over the '75 standards was just a prelude to the battle over the '76 standards. And the '76 standards still stand—for '76. So, instead of a one-year's delay, the auto industry is faced with the same low low limits at the same timetable ('76 = '76). But instead of the original '75 standards, the EPA is imposing another and easier set of interim rules (one for California, another for the rest of the country). The EPA gave the industry all the leeway it could. But the '76 standards are part of the Clean Air Act (Muskie Bill) of 1970, and to change them calls for an act of Congress.

More moderate standards coming

The hydrocarbon (HC) and carbon monoxide (CO) limits are the same for '76 as in the now-abandoned '75 standards. The big difference lies in the oxides of nitrogen (NO_x) limit: from 3.0 grams per mile in '75 to 0.4 g/mi. in '76. The Muskie Bill specified a 90-percent reduction (from '70 levels) in all emissions.

The problem was, in 1970 nobody knew what NO_x content their engines put out. So, you see, the 0.4 g/mi. in the law is nothing better than 10 percent of X!

The White House is not entirely happy about the limits of the Clean Air Act, and chances look good for a revised bill to get congressional approval. The point of this is that cutting auto NO_x to 0.4 g/mi. won't produce anything like corresponding improvement in air quality—and that's what the standards are all about.

No doubt it will take time for new standards to be voted on. But let's look at what can be proposed in terms of what's available:

- Conventional piston engines, no catalytic converters: Just scrape under '73 limits (3.4 g/mi. HC, 39 g/mi. CO, 3 g/mi. NO_x).
- Conventional piston engines with catalytic converters: Can meet '76 standards on low-mileage basis. (Clean Air Act calls for 50,000 miles no-maintenance life.)
- Diesel engines without supplementary emission equipment: Meet '76 limits on HC and CO but not NO_x. Incompatible with catalytic converters because of soot in exhaust, which coats the catalyst and renders it ineffective).
- Wankel engines with thermal reactors: Meet original '75 standards and show promise of meeting '76 limits without catalytic converters.
- Stratified charge, such as the Honda CVCC [PS, Apr.]: Okay for '75 but doubtful for '76.
- Stratified charge, such as Ford's PROCO [PS, July '69]: No conclusive test results as yet.

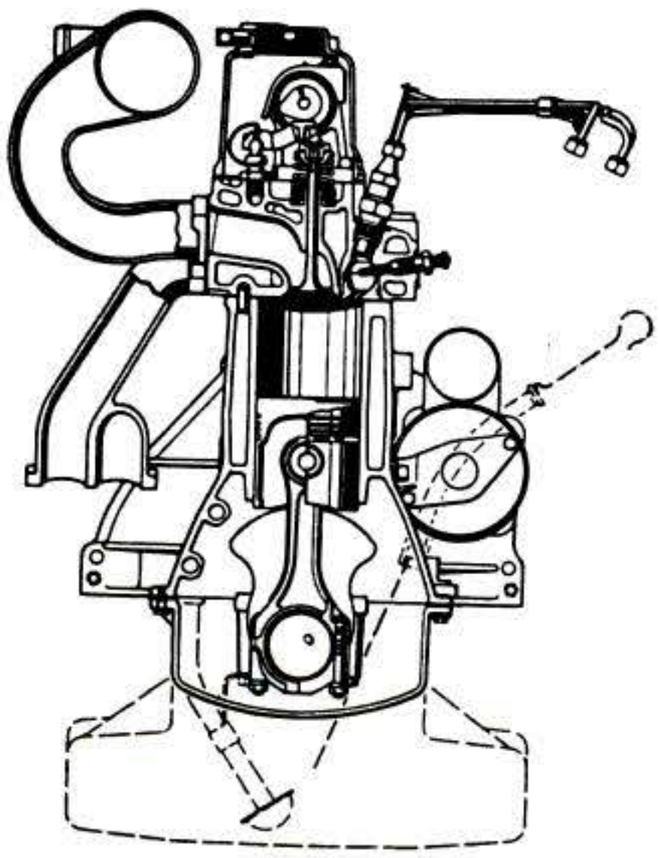
GM's new passenger-car diesel

If reason will prevail, the revised '76 standards will probably be set so as to allow all but the first of the above engine types.

The drawing below shows GM's new passenger-car diesel engine—a modern, SOHC four-cylinder unit built by Opel in Germany and now an option on the Rekord II series.

With 2.1 liters (128.1 cu. in.) displacement, it develops 60 horsepower at the remarkable speed of 4400 rpm. Maximum torque is 87 pound-feet at 2500 rpm, and the torque curve is almost flat from 1000 to 4000 rpm.

Fitted with a turbocharger and installed in an Opel GT chassis with a special streamlined body, this engine gave sparkling performance with complete reliability. It did the flying kilometer at 122.72 mph; the flying mile at 121.666 mph. It covered 5000 miles in 42 hrs. 3 min. 55.4 sec., averaging 118.86 mph.

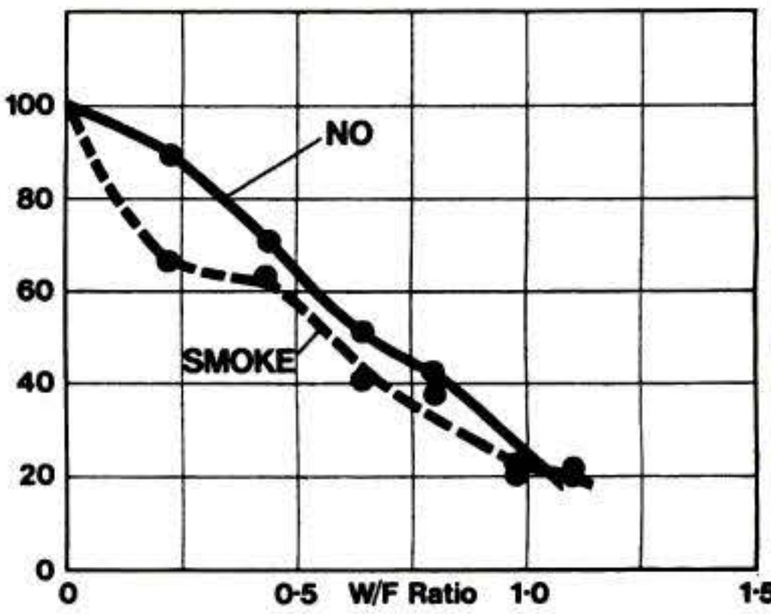


The turbocharger raised power output to 95 hp and won't be available commercially, but it shows what a little diesel can do. Of course, GM is a long way from putting diesels into Impalas, even if they are ready to deliver diesel-powered Opels.

How would a big Chevy run with a four-cylinder diesel? About 20 years ago a taxi fleet in Belgium converted all their Chevrolets to diesel, using four-cylinder Perkins engines, with considerable loss of performance but an even greater gain in fuel economy. The Chevy is bigger and heavier today, but the Nova would make a fine diesel conversion.

Lucas tackles diesel emissions

Lucas is an English company that makes, through its CAV division, more diesel fuel-injection systems than any other company in the world. CAV says direct-injection diesels emit about 8.1 g/mi. of NO_x. The Opel, precombustion-chamber type, probably emits 7.5 g/mi. NO_x.



EFFECT OF WATER INJECTION on NO and SMOK
D.I. engine, 2000 rev/min

Lucas has looked at a number of ways to combat nitrous oxides in diesel exhaust, including exhaust-gas recirculation, turbocharging and intercooling, and—here it comes—water injection.

Water injection experiments show that NO_x content goes down as the proportion of water to fuel goes up. With a 50/50 water/diesel fuel mixture, NO_x emissions are 80 percent lower than without water injection.

That would indicate that direct-injection diesels could be brought down to 1.62 g/mi. and prechamber diesels to 1.5 g/mi. Mind you, this is still in the laboratory stage, but it's an exciting prospect. And Lucas is continuing to work on it.

An equally exciting prospect of the water-injected diesel is that power loss is hardly perceptible, even with a 50/50 mixture. There's a chance that water injection can double the diesel's fuel mileage—already 50-70 percent better than the gasoline engine's. Maybe this will be an important way of coping with the fuel shortage. PS

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Caprice bends over backward to put you at ease.

Caprice Sport Sedan in front of the San Francisco Opera House.

Comfort and luxury are nseparably tied together in Caprice.

Like the available reclining passenger seat, shown above, that independently adjusts up and back. Sink back into this sumptuous seat and watch the world go by.

Then picture yourself behind the wheel. You're sitting on full-foam seats.

Stretch your legs out. Way out. You've got a good yard or so.

Reach out, feel the new soft rim steering wheel—power steering, of course.

Look around. Handsome woodlike vinyl accents, rich feeling knit cloth or pattern cloth fabrics, assist grips on the front doors.

1973 Caprice. You might not want to look any higher.

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Take a second to buckle up. It could save a lifetime.

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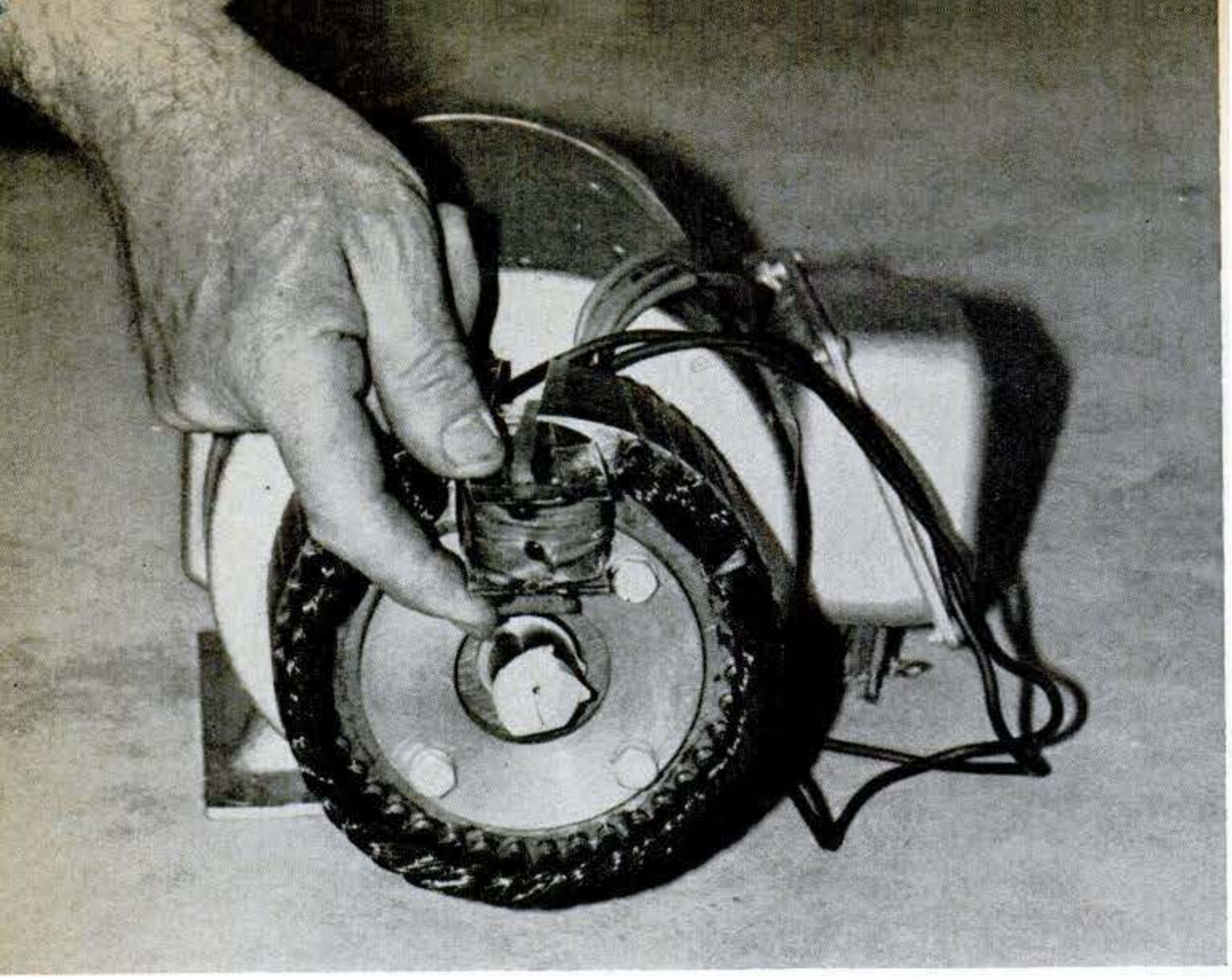
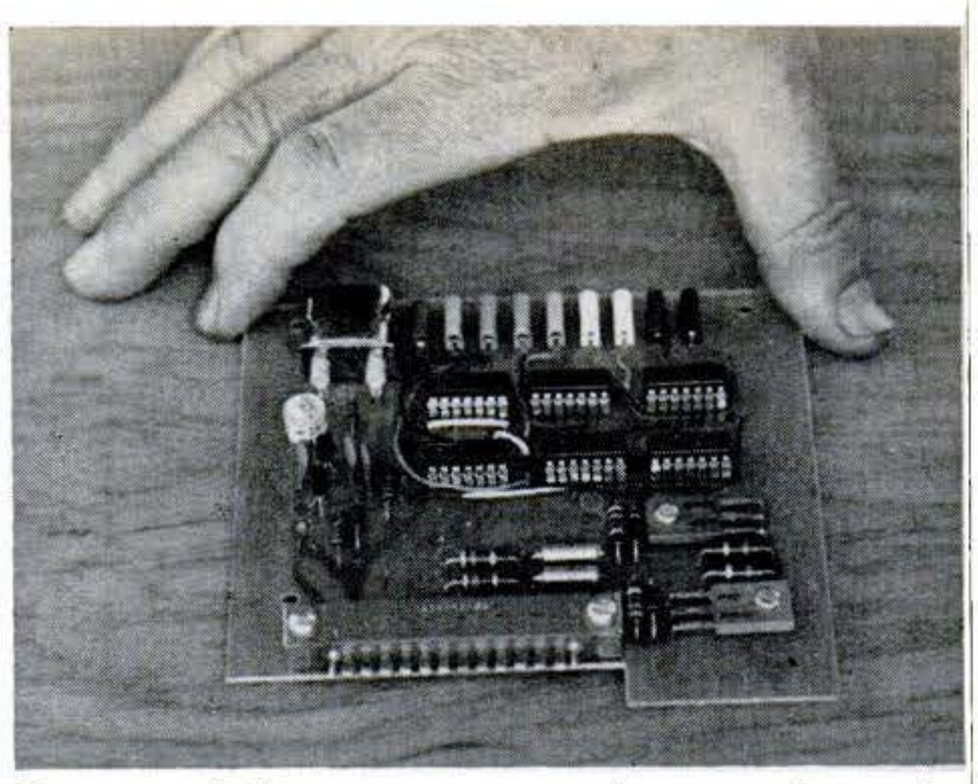
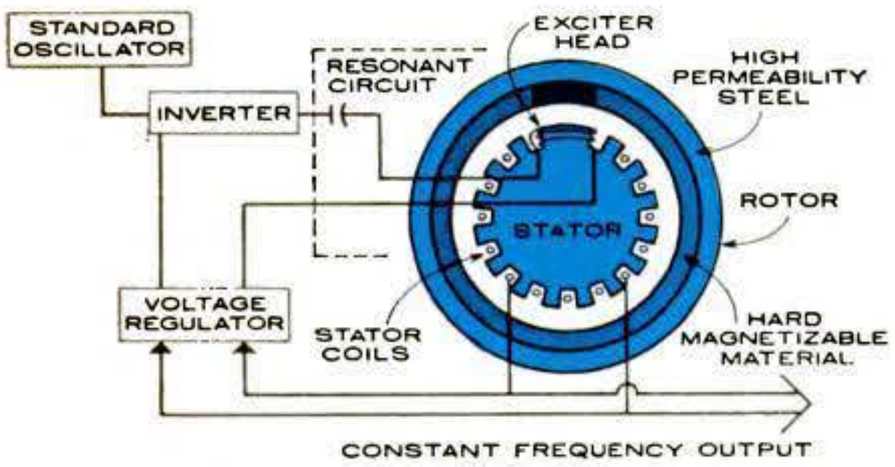




Secret of frequency control at varying rotor speeds is "writer" coil (left) which imprints needed pole position on continuous magnetizable band in housing. Power consumption for rewrite operation is small since pole position changes are small. Circuit board (above) provides write pulses at specific intervals. Crystal-based oscillator frequency is divided to desired operating frequency.

New Alternator Delivers 60-Cycle Power at Any Speed



Oscillator feeds resonant circuit—exciter-head inductance plus capacitor—to write pole positions. Feedback to regulator controls level of write energy.

Packaged 400-Hz, 1-kv converter is driven from 60-Hz line and holds output frequency to plus or minus 0.001 percent. Line spikes and transients are eliminated.

Special magnetic head "writes in" pole positions to compensate for speed

By E. F. LINDSLEY
PS Midwest Editor

I recently watched a Wankel engine driving a generator about the size you might use for home emergency power. The frequency was 60 cycles; just right for feeding your refrigerator or electric drill.

Novel? Amazing? Not unless you realized that engine and generator rotor speed were intentionally varied from 2500 to 4500 rpm while the 60-cycle output, magically, stayed right on the money.

If you've ever worked with generators, this machine appears to violate everything you've learned about magnetic poles, flux, and cycles per second. Here was something new and startling—a generator that virtually ignored rotor speed.

Think back to your high school physics. You probably recall wrapping a coil of wire around a bolt and hooking the wire ends to a volt/ammeter. You discovered that moving a magnet near the coil made the meter needle swing, proving that a moving magnetic field induced current flow in a nearby wire.

Coils and speed. How fast the needle swung depended on how fast you moved the magnet. Technically, the number of needle swings in one second was called frequency. In modern generators, the right *number* of coils and the right *speed* of the magnetized rotor give us common alternating power frequencies of 60, 50, sometimes 400 swings or cycles per second. (Today we say Hertz or Hz for cycles per second, but it's the same thing.)

The big problem has always been keeping the prime mover—turbine, waterwheel, diesel or gas engine—

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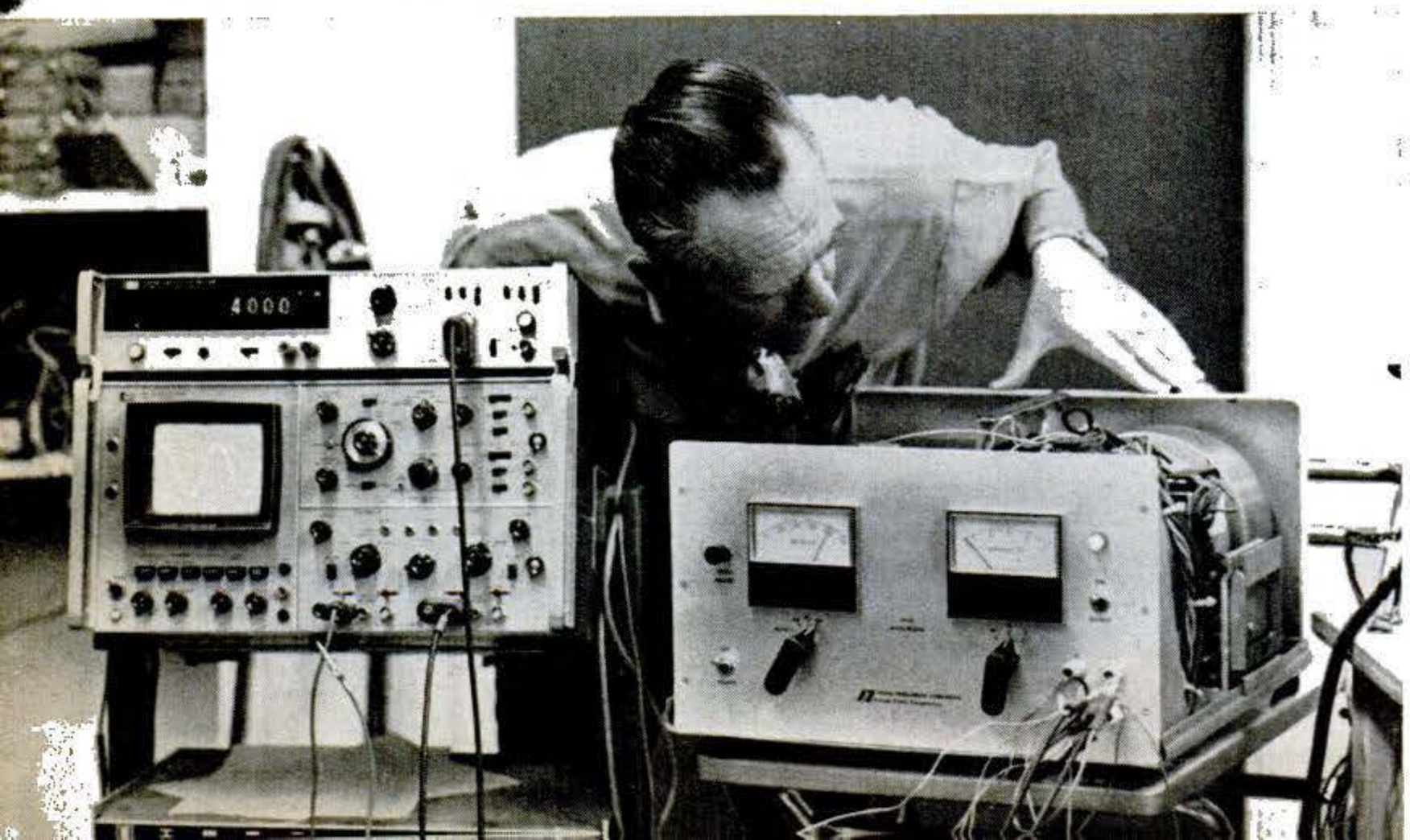

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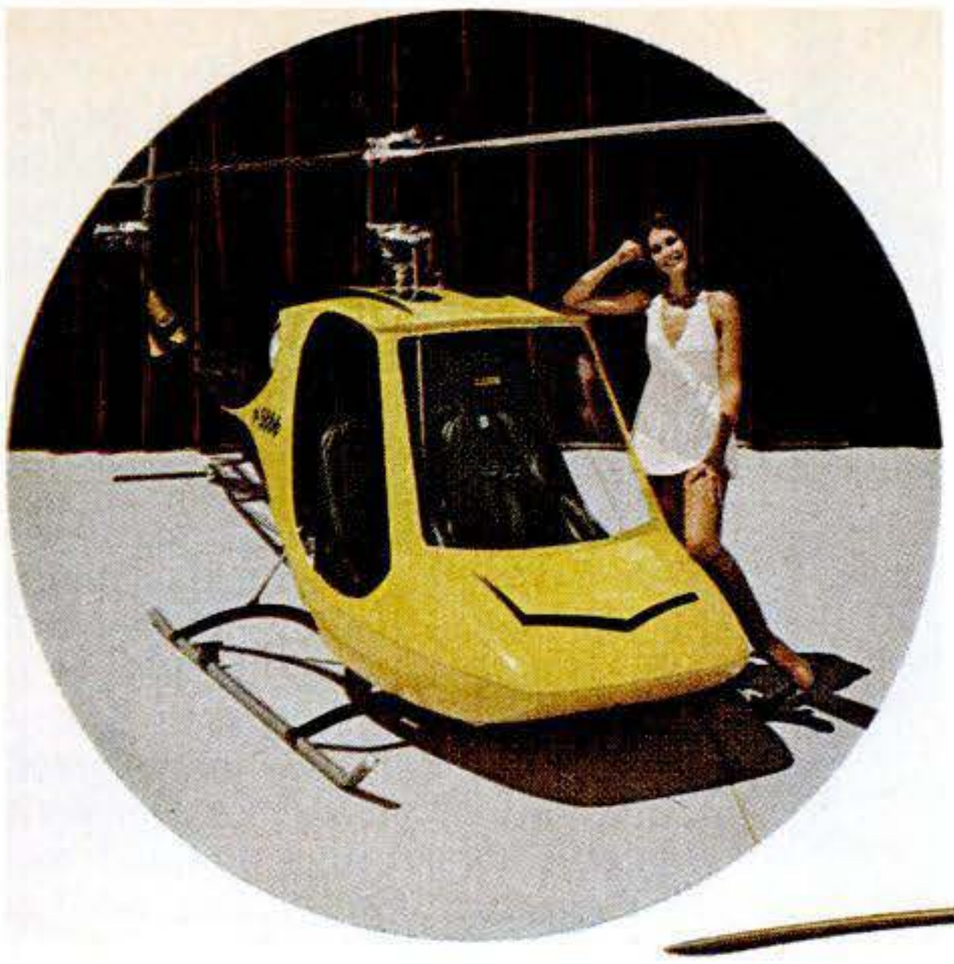

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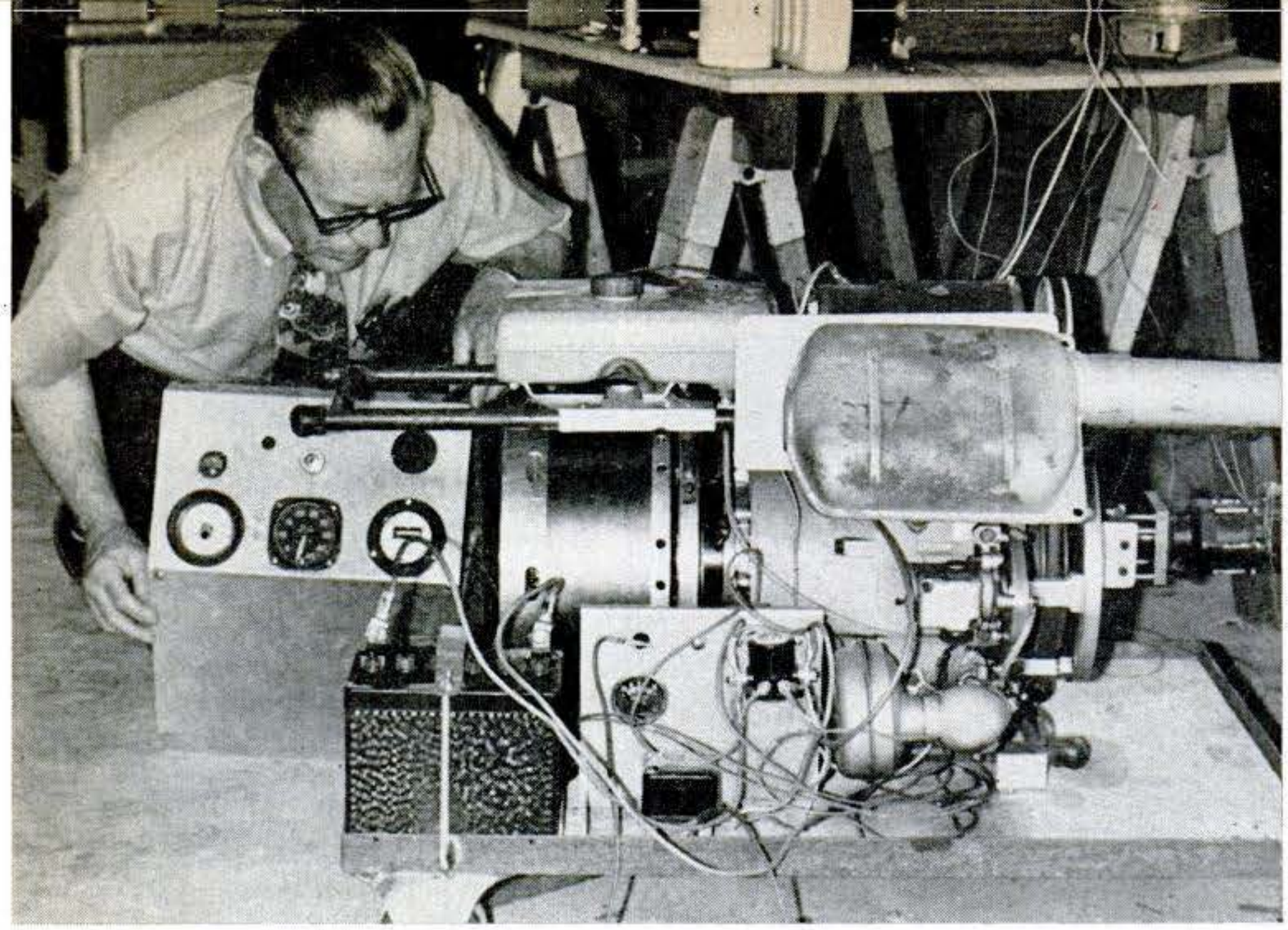

Stable 60-Hz output comes from Precise Power 10-kw generator (center) even though Wankel engine (right) varies from 2500 to 4500 rpm. Voltage held at 120V.

turning at exactly the right speed to hold this frequency. If you're formula minded, recall that:

$$\text{Freq. (Hz)} = \frac{\text{No. of poles} \times \text{rpm}}{120}$$

The constant-frequency rotating generators I saw, made by Precise Power Corp. (Box 1905, Bradenton, Fla.), beat the formula. Rotating speed changed, but frequency remained constant.

How it works. Unlike standard generators with a fixed number of poles, this new device has a unique outer housing, called the rotor, with a continuous layer of magnetizable material lining the bore. The stator has a special coil or exciter head that continuously "writes" the proper pole disposition on the magnetic material.

This writing process is controlled by a precision oscillator and amplifier. The exciter-head coil is the inductance part of a tuned inductance/capacitance resonant circuit. Let the stator speed vary, and the imprinted pole spacing varies to compensate.

According to John Roesel, president of Precise Power, "The stator coils see the same number of poles per second—despite speed variation." Power used for this rewrite is small because most such changes in pole position are partial. Normally, this pole-writing power takes about 50 watts for a one kilowatt output. Overall efficiency is about 65 percent, better at higher outputs.

I wondered about voltage regulation with all these startling activities going on. It turned out to be very good. By sampling the output and using the feedback to regulate the amplitude of the pole-writing power, voltage generally holds within 1.5-3 percent depending on type of unit.

Frequency precision can be built in to suit your needs. A crystal-controlled, solid-state circuit can be set up to hold frequency within 0.0001 percent, tighter than most finicky applications would require. For most jobs, one percent is fine.

One generator I saw was able to hold plus or minus 0.01 percent even when driven by a one-lung lawnmower engine. Another, driven by simple induction on a 60-Hz power line was putting out 400 Hz, plus or minus 0.001 percent. Surprisingly, even a momentary interruption in line power did not shake the 400-Hz output.

Still another demonstration model was able to coast along several seconds on flywheel energy when the line power was cut. It then picked up on a separate air-motor drive without a flicker on a sensitive, digital-readout frequency counter.

Admittedly, the big power companies have been keeping their huge steam-turbine and hydro plants sharply tuned to 60 Hz for years. Without reasonably good frequency control they'd have a dreadful time switching feed systems, synchronous motors would go crazy, and millions of electrical devices would be in trouble.

Frequency problems. But now a whole new world of frequency problems has arisen.

- New power sources—solar, wind, small steam expanders—that can't be precisely governed will take up part of the energy shortage, especially in remote and developing areas.
- Some computers, medical apparatus, and other critical circuits cannot tolerate even momentary interruptions or frequency excursions.
- Changeovers from 50-Hz to 60-Hz power now going on, in Mexico for example, leave both householders and factory managers in a quandary on how to use older 50-Hz equipment with 60-Hz power.
- Small emergency or off-line power plants can't (practically) be governed accurately enough to hold frequency closer than five percent. For intensive-care hospital equipment or air-navigational facilities this can be hazardous.

Surprisingly, the first customer for Precise Power's generator is a major power company. They need precise power, free of peaks and transients, to supply their computers and monitoring gear. Moreover, they need no-break or non-interruptible power.

Standby power. A no-break system uses line power to run a motor that, in turn, drives a generator. At the opposite end of the generator a diesel or gas engine stands ready to start up and keep the generator turning if the main line goes dead.

It's the time lag between motor drive and engine drive that kills computers and their kin. Most no-break rigs use a flywheel to keep the generator turning until the engine can start and clutch in. Even so, the flywheel energy starts to decay and frequency drops during the transition.

With Roesel's generator, however, frequency stays steady regardless of flywheel slowdown. A computer, or any other frequency-sensitive load, isn't affected by the slowdown. Or, if power interruptions of only limited duration are your problem, Roesel can plant a combination hydraulic/pump/motor between the input motor and the generator.

Hydraulic motor. The hydraulic pump stores up pressure in a reservoir; when a break occurs, hydraulic fluid flows backward through the pump—now a hydraulic motor—to drive the generator. Meanwhile, the frequency remains constant.

If you want to harness winds, small steam or Freon expanders, or solar-heat sources, you've got worse speed-control problems. Even small diesel, gas, and gasoline engines use windvane, or, at best, crude flyball governors. Hanging a precise hydraulic or electric governor on any of these is expensive and impractical.

But the demand for controlled-frequency power nevertheless exists and is growing everywhere—from jungle hospitals to remote communications centers to the basement of your own city firehouse. John Roesel's Precise Power generators are the first we've seen that can do the job at modest cost. If it's electrical treason, we bet a lot of people will make the most of it. PS

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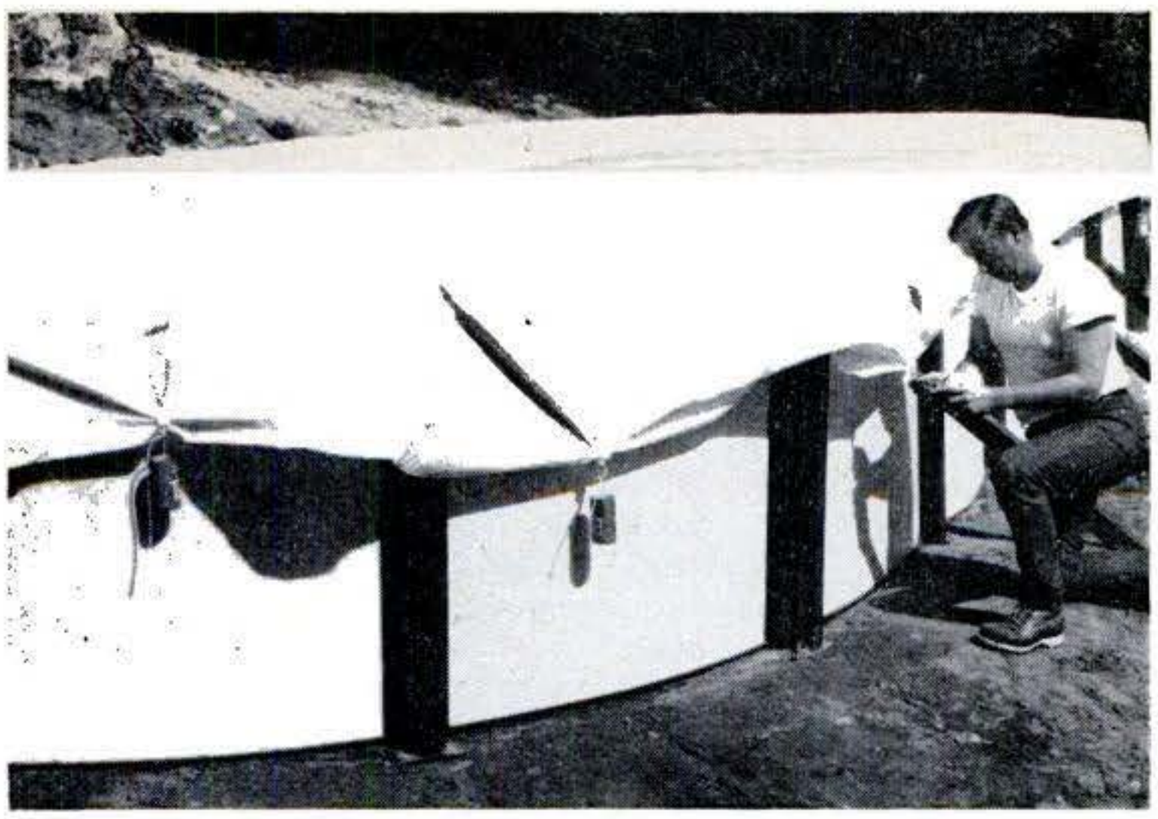
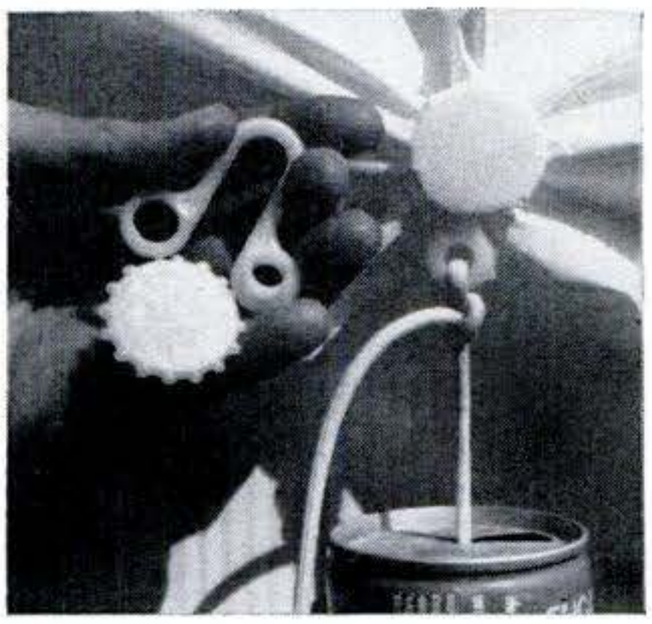


Cement-filled cans anchor the homemade Tu-Tuf cover.

PERSONAL-USE REPORT

Plastic That Won't Tear



Sto-Downs fit behind gathered plastic, and clamp tightens around stud leaving ¼" tie-down holes.

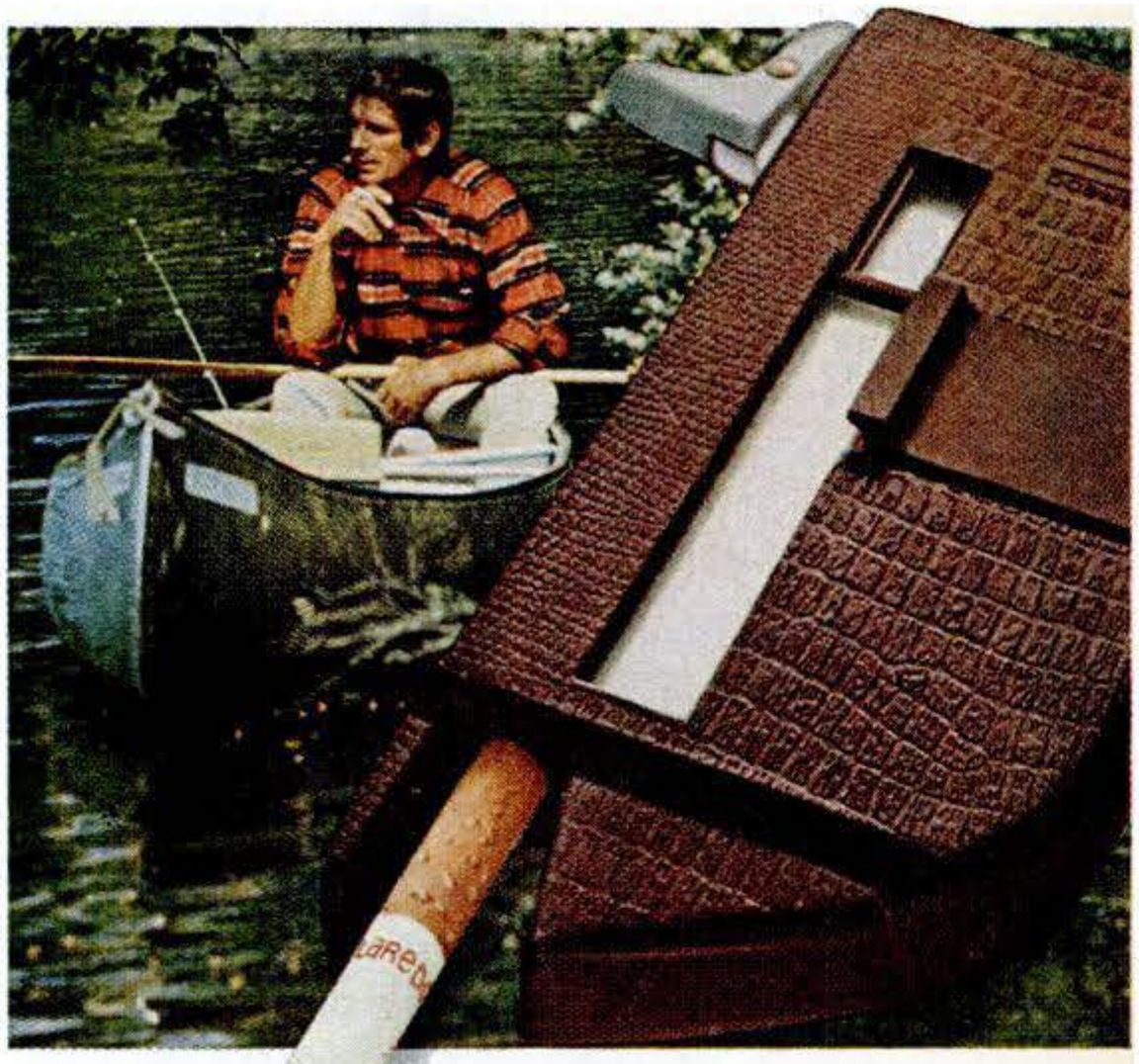
At a builder's convention recently, I took on one exhibitor's challenge: Tear up a sample of his new polyethylene sheeting called Tu-Tuf. Though the sample was only four-mils thick, I couldn't rip it. The stuff stretched, but wouldn't tear. Then I tried tearing his 2½-mil poly. Still no luck. The reason, I learned, was that this new sheeting is cross-laminated, like plywood, for strength. In whatever direction you try to rip it, you're working against the grain. This makes the poly hang in when the going gets rough. It resists tearing and flapping in the breeze, or all-too-soon disintegration into flakes, like some cheap polys I've known.

Tu-Tuf certainly looked great for things like swimming-pool covers, boat blankets, or protective tarpaulins for cars, motorcycles, and piles of lumber, so I got a roll of the four-mil thickness. I also picked up some of the same firm's reusable plastic grommets. Called Sto-Downs, these let you fasten tie-down cords to the plastic sheeting without cutting holes in it.

With my daughter's help, I needed only 20 minutes to cut and install a cover for our 32-by-16-foot family swimming pool, including grommets, tie-downs, and all. The cost was half what a regular pool cover of that size goes for. According to tests performed for the manufacturer, Tu-Tuf should withstand the equivalent of a year's weathering in the tropics and suffer less than a one-percent loss in tensile strength. If my homemade cover lasts a year, I'll be happy; two years, and I'll be delighted. That's par for any low-cost cover.

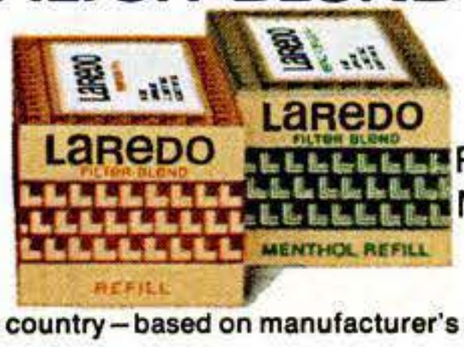
Tu-Tuf 2 (2½-mil) comes in white. Tu-Tuf 4 (four-mil) comes in white, black, and combination white-black (possible with cross-lamination). Tensile strength is said to be 20 pounds per inch of width for the 2½-mil, 32 pounds for the four-mil. Prices run from five to seven cents a square foot from Sto-Cote Products, Inc., 2139 Wayne Ave., Chicago 60614. —*Richard Day*

THIS MACHINE CAN TAKE YOU FISHING.



It's Laredo's cigarette-making machine. Makes 20 great-tasting cigarettes at less than 20¢ a pack*, a big difference compared to factory-made cigarettes. You pocket the savings that can soon take you on fishing trips, or buy some of life's other little pleasures... from a new rod 'n reel to you-name-it. Freshness, flavor and big savings! Get them all for just a few easy minutes every day. Land a Laredo Filter Blend Kit now. What a catch!

LAREDO
FILTER BLEND



Regular or Menthol

*In most areas of the country—based on manufacturer's suggested retail price.

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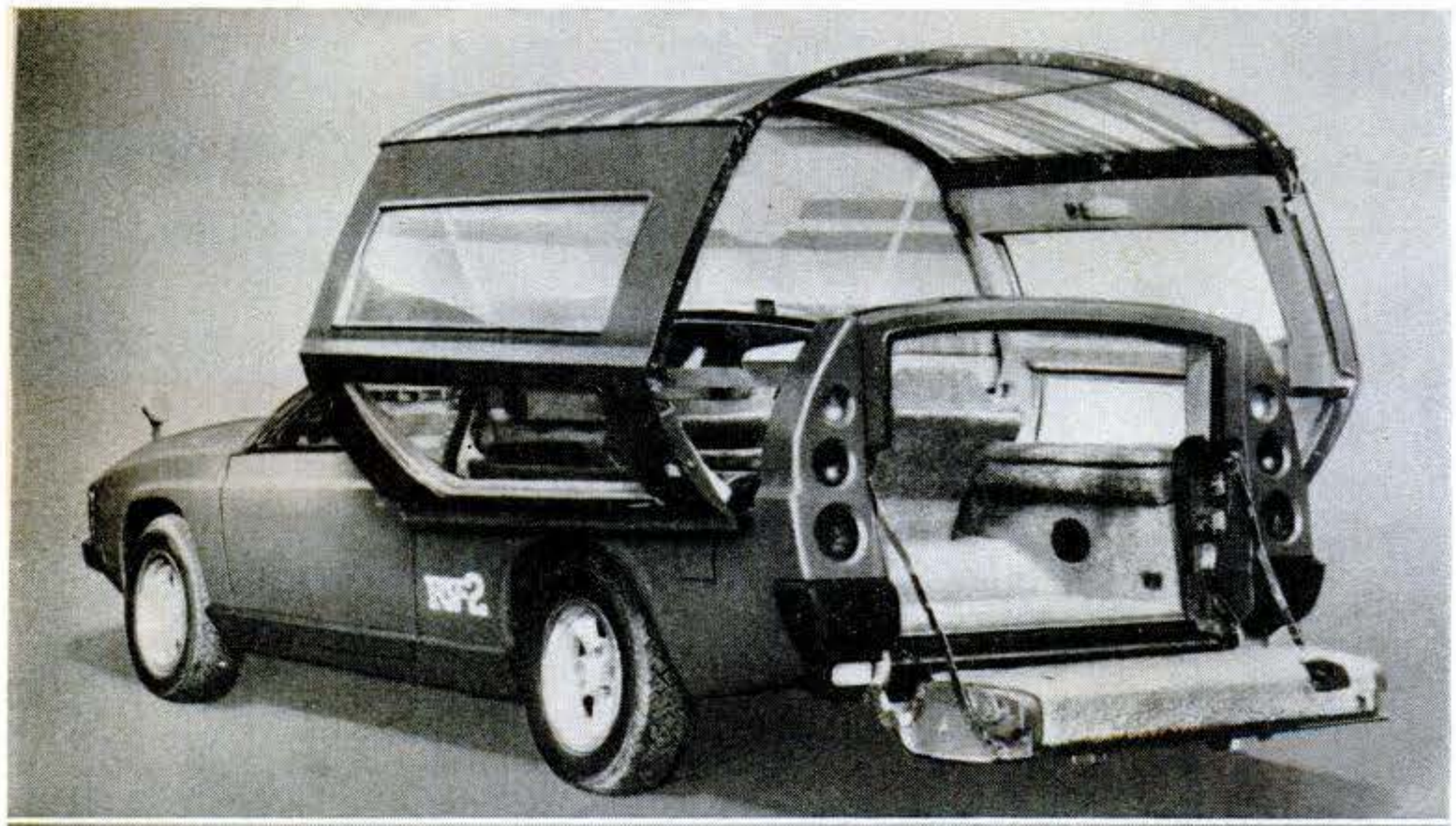
Recreation Roundup

. . . on the go with PS—on and off the road

By HERBERT SHULDINER



"Idea" car turns a station wagon into a recreational vehicle

Toyota recently unveiled this jazzy-looking station wagon at the New York auto show. The station wagon (bottom photo) opens into a roomy camper (top). Toyota calls this 186-inch-long car the RV-2. It seats four, and stores in any garage. But the clamshell canopy can be unfolded anytime you're parked, and there's enough room for the passengers to eat and sleep inside. Beds, table, and chairs store neatly inside when not in use.

Unfortunately, there are no definite plans to produce this unique RV, but it's interesting to see auto manufacturers cooking up some attractive new ideas.

RCs on the water

OMC's new racing outboards never finished their first race. But the second time around—at the one-hour Galveston (Tex.) Speed Classic recently—they came in one-two-three. (A fourth rotary-combustion engine flipped and didn't finish.) This spectacular performance proves the rotaries a force to be reckoned with. Mercury apparently feels that way: They didn't even enter their racing team to compete with Johnson and Evinrude crews dominating the race.

The performance data collected should hasten marketing of OMC's rotary engine. But the Outboard Marine Corp. indicates that's not due until 1975 at the earliest.

More Chevy competition: 4WDs

Last month, Jim Dunne reported [Detroit Report] that there would be a new Bronco. Now we've learned that Dodge is also readying a Blazer-type 4WD. Both are due in time for the '74½ season or '75 at the latest.

The new off-road vehicles will be based on both companies' light pick-up trucks with four-wheel-drive components—identical to the route Chevrolet took to produce the Blazer.

CG crackdown on small boats?

The Coast Guard has announced a proposed amendment to the Federal Boat Safety Act which could have a far-reaching effect on small-boat owners. It would allow CG officers to evaluate the design, seaworthiness, and equipping of boats—as well as the competence of the crew—before trips. Then the officer could declare the boat or skipper unsuitable for the trip, and have the power to stop the boat if it leaves port.

George Rounds of the National Assn. of Engine and Boat Manufacturers, says the objectives are good, but says the proposed regulation "smacks of undue restriction on the personal freedom of the boatman."

The CG says it plans "infrequent implementation of the regulation."

Groovy signs help bikers

You may soon see a new sign on highways all over the country: GROOVED PAVEMENT. It's a warning specifically for motorcyclists.

The sign program began in response to protests from motorcyclists who find that grooved pavement adversely affects bike handling. Highways have this grooving because it's thought to cut down on auto accidents in the rain. But instead of improving traction for motorcycles, it actually makes footing more treacherous for them.

Campgrounds offer motel rooms

KOA, the nation's largest franchised campground system, has begun offering motel accommodations at six of its sites located along US 66 and Interstate 40, in the southwest. Rooms will cost $8 to $16.50 per night for four people.

KOA says the motel units are designed to appeal to families who like to camp, but lack camping equipment—or those who are put off by the high prices charged by regular motels.

Things to write for

Want to save on campsite fees? "Free Campgrounds" lists hundreds of campgrounds where you can park without any cost, and others where the fees are about $1. It's available for $2 from Box 5206, Topeka, Kans. 66605.

"Guidelines to Safe and Carefree Camping" is a new pamphlet you can obtain free from Dodge dealers, or Box 970A, Detroit, Mich. 48231.

A new kind of recreation map has been published specifically for RV owners. Six maps tell you everything you need to know about camping in Florida, Texas, New York, Vermont, New Hampshire, and California. The maps warn where there are winding roads, windy and congested areas, steep grades—and give you alternate RV routes. They show picnic and rest areas, scenic tours, as well. Maps are $1.95 for each state, from Gousha Publications, PO Box 6227, San Jose, Calif. 95150. PS

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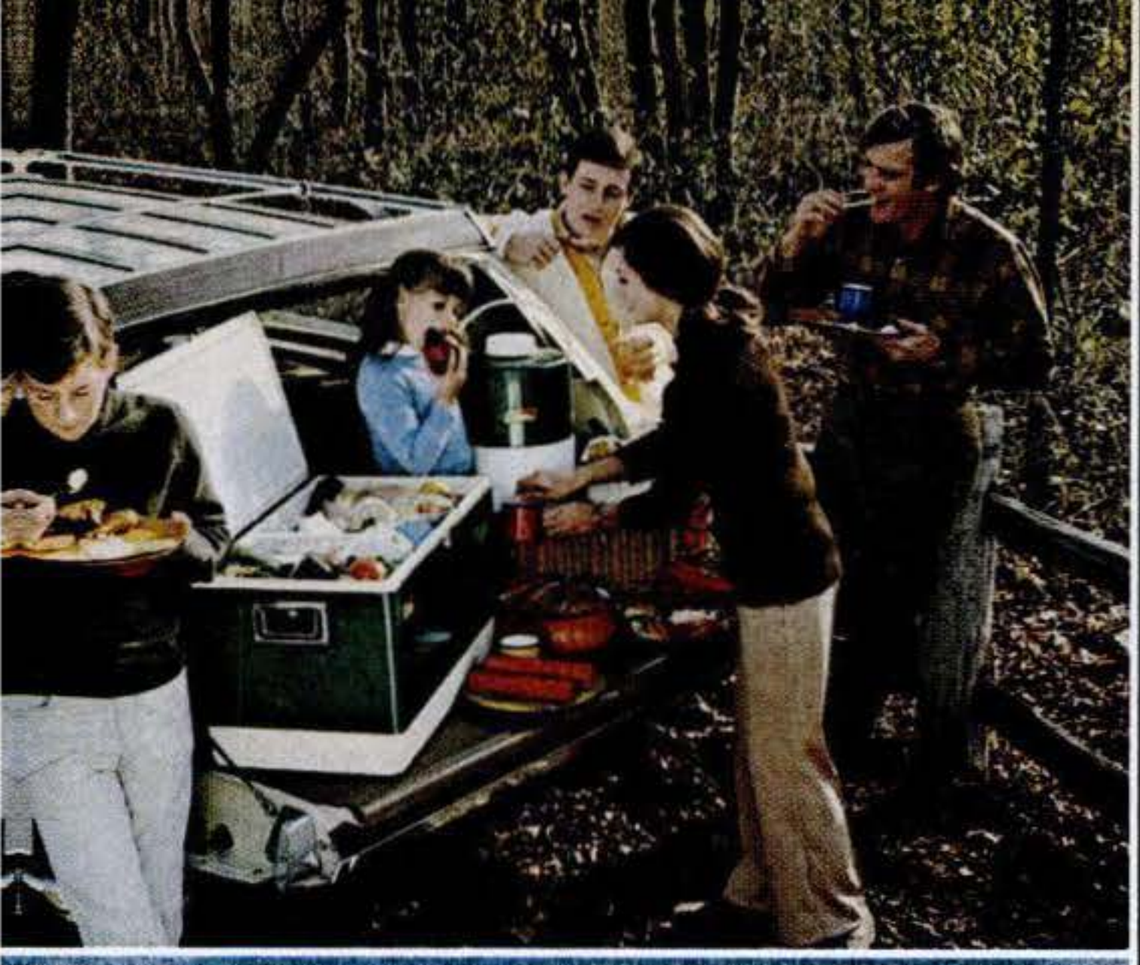


Coleman Coolers and Jugs.

Sturdy. Cold hugging. The closest thing to having a refrigerator along in the great outdoors. That's how Coleman builds them.

With polyurethane insulation in both coolers and jugs. Plus one-piece plastic liners that can't rust, corrode or stain. So your food and drinks always stay clean and fresh.

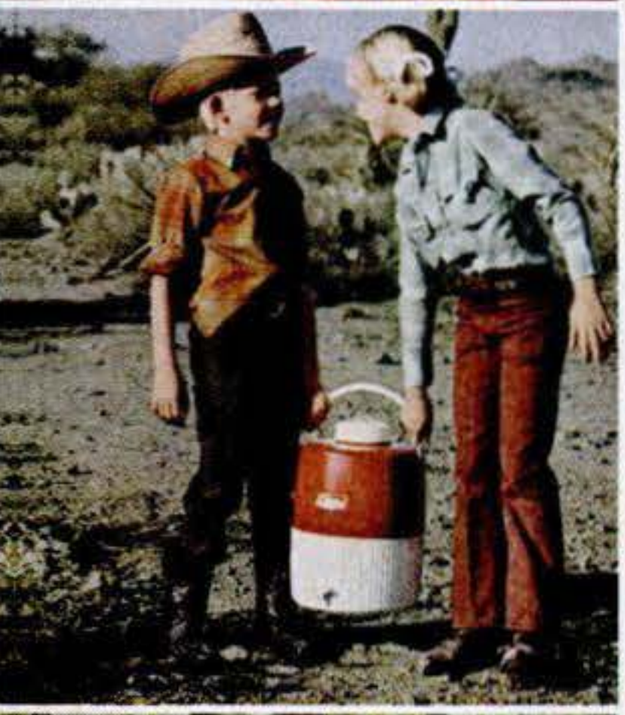
Choose from Coleman's famous Snow-Lite® coolers with heavy-gauge steel covers, with baked enamel finish. Or Coleman's new Poly-Lite® line of tough, high density polyethylene coolers. Both look great. But more important, they really hold the cold . . . hour after hour, day after day.

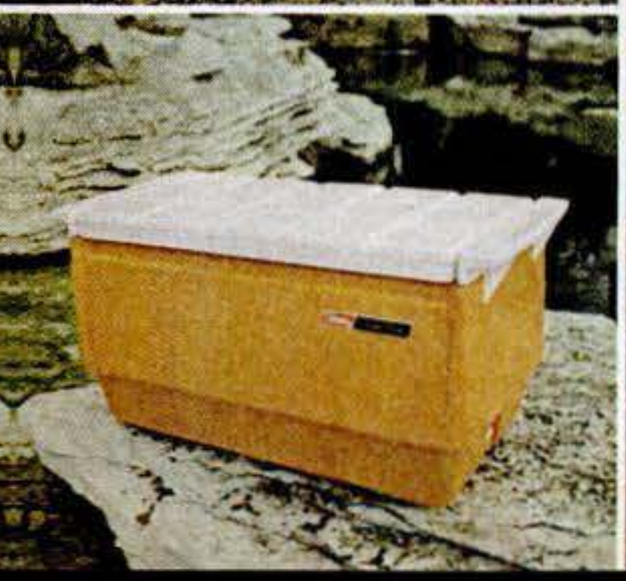
And there's a wide variety of styles. There are ten coolers in all, from the colossal 80-quart capacity to the easy-to-pack 28-quart size. And a choice of four jugs that hold from 1 to 3 gallons of your favorite beverage.

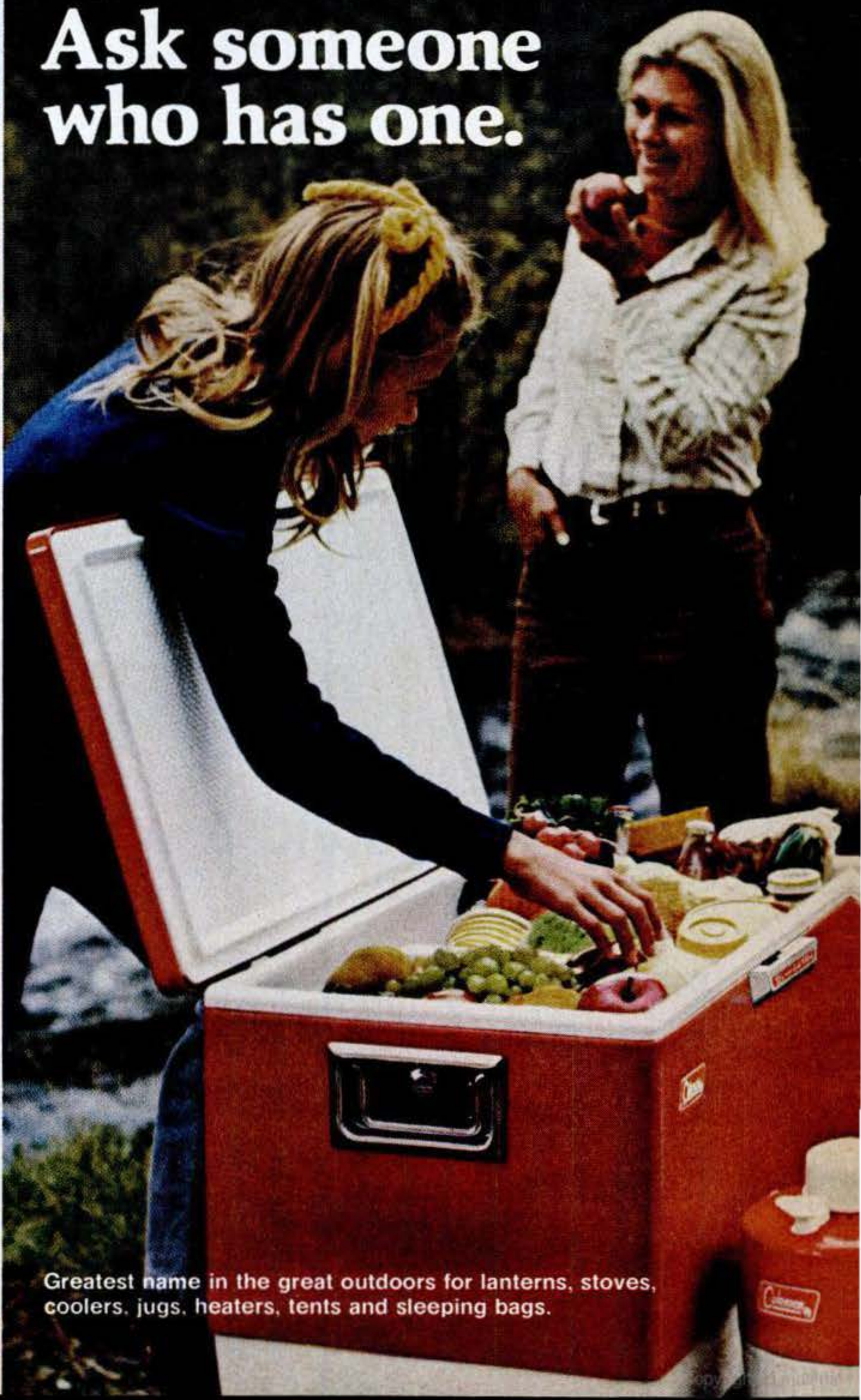
Coleman doesn't believe in cutting corners. Our coolers and jugs prove it.

Coleman®

Ask someone who has one.

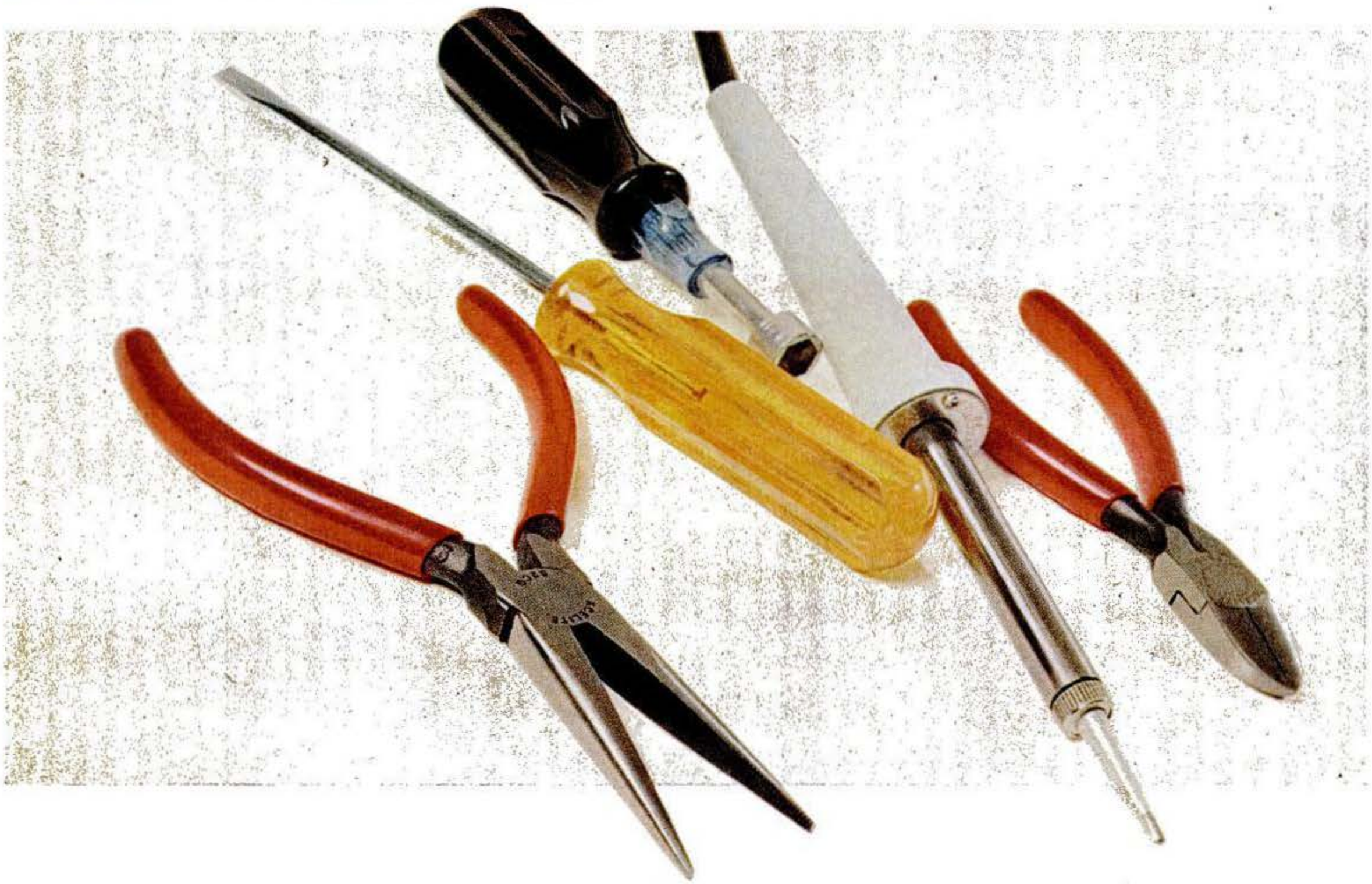






Greatest name in the great outdoors for lanterns, stoves, coolers, jugs, heaters, tents and sleeping bags.

IF YOU CAN USE ANY OF THESE TOOLS...



...you could build a whole new future...

and build yourself a Bell & Howell solid state color TV while you're at it!

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If you're already handy with a set of tools, here's a way to pick up a pretty thorough knowledge of electronics: build yourself a solid state color TV as part of a complete learn-at-home program from Bell & Howell Schools.

This important project gives you valuable "hands on" experience with solid state circuitry—the kind of *practical* experience you'll need to build a successful career. It's a vital part of your total electronics education.

Once you've completed your program, you could be ready to build a new career —or start a business of your own—in home entertainment electronics.

Fix stereo systems . . . FM-AM radios . . . phonographs . . . tape recorders

With your new skills, you can build and service stereo-hi-fi systems — including FM-AM radios . . . phonographs . . . open reel tape recorders and cassette or cartridge player/recorders. You could even build yourself a complete "home entertainment communications center"—complete with the new gadgetry of cartridge television when it comes out. The skills you build up by following this brand-new program are more than enough to service almost *any* type of home entertainment electronic device.

A complete at-home learning program in home entertainment electronics

Don't confuse this program with an ordinary hobby kit. It's much more than that. It's a complete at-home learning program prepared by skilled instructors at Bell & Howell Schools.

It doesn't matter if you've never had any training in electronics before. Nobody's going to start throwing "diodes" and "capacitors" at you right off. You start with the basics. You take it one step at a time. You walk before you run. And you'll be amazed at how quickly you start to feel comfortable with things that seemed complicated at the beginning.

Attend special "help sessions" if you like

In case you should run into a sticky problem or two—one that you can't handle on your own—come in and see us. We've scheduled help sessions every few Saturdays at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Drop by. Meet an expert instructor in person. Talk over any rough spots with him—and with other students. You'll enjoy the chance to "talk shop."

Master the most up-to-date solid state circuitry

Solid state is here to stay. Not just color TV but almost every type of electronic device will eventually move farther and farther in the direction of *total* solid state circuitry. Get to know the most advanced "trouble-shooting" techniques for these sophisticated circuits. You'll find an almost irresistible demand for your skills.

Why you *should* know electronics

No matter where you look, the amazing technology of electronics is becoming a bigger and bigger part of the picture. More and more automotive parts and diagnostic instruments are electronic. Many large manufacturing plants use sophisticated electronic systems—controlled by a few skilled electronics technicians. The increasing use of two-way radio . . . the huge promise of cable television . . . the astonishing growth of electronic data processing all open doors to exciting new career opportunities for the man with thorough training in electronics. In fact, the day may come when the man who does *not* have electronic skills will be severely handicapped in many industries.

Why you should get your training from Bell & Howell Schools

Skilled instructors at Bell & Howell Schools—carefully selected for their knowledge, experience and teaching ability—plan each program with the utmost care and attention. Each year, they spend about $200,000.00 improving programs and materials and keeping them in step with new developments in electronics. Thousands of people have used their Bell & Howell Schools training as the foundation for new careers and businesses of their own in electronics.

You build and keep the exclusive Bell & Howell Schools Electro-Lab® —a complete laboratory-in-the-home

To make sure you get practical experience with instruments used daily by professionals, you build and keep a Design Console, an Oscilloscope and a Transistorized Meter (see details at right). These are the three instruments you'll work with constantly—both during your program and thereafter.

CONSIDER THESE ADVANTAGES:

Help Sessions We've scheduled "help sessions" every few Saturdays at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Top instructors give you expert guidance and you meet other students, too.

Resident Study After you complete your program, you can transfer to any of the resident schools for more advanced study, if you wish.

Lifetime National Placement Assistance When you complete your course, we help you locate a position in the field of Electronics that fits your background and interests. This unique service is available at *any* time after you graduate.

Veterans' Benefits We are approved by the state approval agency for Veterans' Benefits. Check the box for details.

Student Financial Aid We are an eligible institution under the Federally Insured Student Loan Program. Check the box for details.

Detach postage-paid reply card and mail today for free information

25-inch picture (measured diagonally)

- **Bell & Howell Solid State Color TV.** Ultra-rectangular tube . . . 25-inch picture measured diagonally . . . full 315 sq. inch viewing area. Solid state modular circuitry . . . 4 advanced IC's . . . 100 transistors . . . 72 diodes . . . individual plug-in circuit boards. Special UHF/VHF tuning features . . . built-in self-service components.
- **Design Console** Use this to rapidly "breadboard" circuits without soldering. Equipped with built-in power supply . . . test light . . . speaker . . . patented plug-in modular connectors.
- **Oscilloscope** Portable 5-inch wide-band oscilloscope offers bright, sharp screen images . . . calibrated for peak-to-peak voltage and time measurements . . . 3-way jacks for leads, plugs, wires.
- **Transistorized Meter** Combines most desired features of vacuum-tube voltmeter and quality multimeter. Registers current, voltage and resistance measurements on a large, easily-read dial. Features sensitive, 4-inch, jewel-bearing d'Arsonval meter movement.

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International Scout descends into a gulch (above, left) as the Chevrolet K5 Blazer (lower left) climbs out of another. Ford Bronco (right, above) takes a leap, while the Jeep Wagoneer (lower right) makes its way out of a rutted forest path.

PS Ratings—Test Report in a Nutshell

The table below shows our ratings for 10 performance or design areas in the four vehicles tested. The ratings are based strictly on test results and actual measurements. Personal bias or subjective opinion play no part, as the ratings have a direct mathematical relationship to test data and specifications. Five points is excellent; 4, very good; 3, good; 2, fair; 1, poor; and 0, very poor.

	Blazer	Bronco	Scout	Jeep
Acceleration	0	2	2	2
Brakes	3	2	1	3
Handling	2	1	3	2
Maneuverability	4	4	3	3
Fuel economy	0	0	0	0
Quietness	1	0	0	0
Ride comfort	(1)	(0)	(1)	(2)
Roominess	5	3	4	4
Visibility	1	3	1	2
Entry/exit	3	3	5	5

POPULAR SCIENCE • CAR TEST • NORBYE/DUNNE REPORT

With features like full-time 4-wheel drive, V8 engines and automatic transmission, power steering and brakes, these vehicles are as easy to drive as passenger cars

The 4-Wheel-Drive Multipurpose Cars Are Better Than Ever

By JAN P. NORBYE/*PS Automotive Editor*
and JIM DUNNE / *PS Detroit Editor* PHOTOS BY ORLANDO GUERRA

You probably take it for granted that these vehicles have the off-road mobility that's demonstrated in the pictures above. But did you know that these cars can also cruise at 70-80 mph on the highway, with ride comfort approaching passenger-car standards? They would surprise you.

Because they will do most of their mileage on highways, they need passenger-car handling and maneuverability. We put them through our regular test procedures. But we

Continued

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King Size, 17 mg. "tar," 1.2 mg. nicotine; Long Size, 18 mg. "tar," 1.3 mg. nicotine av. per cigarette, FTC Report Feb.73.

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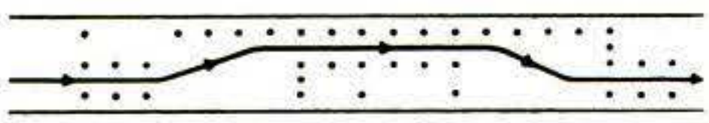
Standardized handling test shows evasive ability



Two lane changes in quick succession show a car's handling precision in a high-speed emergency maneuver. The car swerves left to avoid a barrier in right lane. Left lane is blocked 120 feet beyond right-lane barrier. Open lane-change gaps are 60 feet long, and lanes 12 feet wide. Each run is timed, and each car makes several runs until its minimum time has been established. Scout was fastest, equaling the Pontiac Grand AM's 60 mph [PS, May]. Scout and Bronco made this test with rear-wheel drive only —as recommended for highway driving. Jeep and Blazer have full-time four-wheel drive, but that's not why they were slower. Blazer tended to drift; Jeep lacked steering precision; Bronco lacked stability. Scout had firm understeer, minimal sway (roll), and a well-behaved rear axle. Photo is a montage of two runs.

didn't stop there. We also tested them out in the terrain (though we have no standard test procedure for off-road capability, we'll report our observations on how they ran).

Are they for you? Should you buy one of these cars? Look at what you get:

- Go-anywhere capability with new ease of driving.
- Versatile body type, with easy wagon-to-van convertibility, and a high load-carrying capacity.
- High-powered engines and trailer-towing capability.
- Adaptability to snowplow use, and availability of power takeoff.
- Full compatibility with turnpike-traffic needs.
- Truck-type ruggedness, quality, and reliability.

On the other hand, you should be aware of what you don't get.

For one thing, you don't get one of these rigs for peanuts. They are relatively high priced. And they're not cheap to run. Not one of them was able to get better than a 0 rating for fuel mileage.

They don't conform to passenger-car safety standards, but to another set of standards developed for multipurpose passenger vehicles. What's the difference? They don't have buzzers, they don't have shoulder belts. They aren't required to have collapsible steering columns (but they all do now). They aren't required to have steering locks (but the Bronco is the only one of the test cars not so equipped).

As you get deeper into your examination of the four-wheelers you find more and more differences. They differ greatly in size and weight, and they differ enormously in their drive-train options. And even the basic chassis specifications show some surprising differences.

The Bronco, for instance, has coil-type front springs. The others use leaf springs. The Blazer is the only one with front disk brakes—the others have drums all around.

The Wagoneer stands out for its all-steel body structure. The others have plastic roofs bolted on. The roof can be removed to convert the vehicle into a pickup, but it's not an easy job, and few owners ever take the trouble. The Wagoneer offers four-door convenience. The others have two-door bodies, and access to the back seat is from the right side only on the Scout and Blazer.

Chevrolet Blazer. This is the only vehicle of the four that shares its major body and chassis components with the regular pickup-truck line. The Blazer is really a variant of the C-10 Chevy which was redesigned for 1973. This cuts costs.

As a result of this design, the Blazer is the largest vehicle in the group. Size is no handicap on the highway, but it restricts off-road mo-

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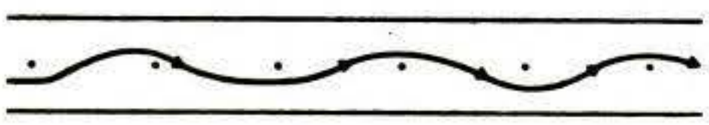
PS maneuverability test tells all about steering



Driving as fast as possible on a snake course between pylons spaced at 48 feet is a severe test of the entire steering system. Any shortcomings in choice of steering ratio, power-steering reactivity, roll-steer phenomena, turn diameter (maximum steering angle), and tire stability and sidebite, will show up as reduced speed. Cars that can take this test at 26 mph or better have excellent maneuverability. Slower cars have reduced evasive ability. Above, the Bronco on its fastest run (25.7 mph) shows severe roll and strong oversteer (lack of stability). It was hampered by uncommonly slow-geared power steering needing almost six turns of the wheel from extreme right to extreme left. All four cars ran at speeds well above the norm for large passenger cars built in the United States.

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We ran one of the toughest rallies in Europe on passenger car tires.

Sears Steel-Belted Radials took on the Rally of the Acropolis 1972. A rally so tough, that of the 98 cars that started, only 14 finished. But this Datsun finished near the top — running on Sears Steel-Belted Radials. Tires you can buy for your own car.

It took three days of tortuous driving over the rutted twisting roads of Greece to run this rally. From Athens, through the rugged mountain passes of the Peloponnesus, and back again. Tires were changed in accordance with rally procedures.

What makes Sears Steel-Belted Radials so special? Two flexible steel belts for impact strength, wrap-around radial design for road-hugging traction, over seven years of proven performance on all kinds of roads— all combine to make this possibly the toughest, best handling tire you've ever driven.

It's the same tire that's been driven over 70,000 miles on American highways. Of course, like any tire, the mileage you get depends on how you drive.

For more details and official FIA rally results pertaining to Sears tires write Sears, Roebuck and Co., Dept. 695, 303 East Ohio, Chicago, Illinois.

Sears
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Sears Steel-Belted Radial.

Proven for toughness, traction and mileage on the tough roads of the world.

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How PS tests brakes—and what we learn from it

We test a car's ability to stop within a 12-foot-wide lane from 60 mph without front-wheel locking. The test is first made with cool brakes to show brake capacity and balance. Then it is repeated after 10 warmup stops from 60 mph with 0.5-g deceleration at one-minute intervals, to show fade resistance. Stopping distance, pedal pressure, and rate of deceleration are recorded. The Jeep (above) achieved the shortest stop with cool brakes, but suffered some fade (it had drum brakes all around). The Blazer achieved the shortest stopping distance with hot brakes —as expected, due to its front-wheel disk brakes. All four cars showed a tendency to lock the rear wheels, and all had poor lateral stability. It took fast corrections with the steering wheel to keep them within the lane.

Free-wheel front-wheel hub on Ford Bronco is locked and unlocked by a simple twist of your hand (no tools required). Hubs are made by Warn Mfg.

International Scout has similar front-wheel hubs. Free-wheeling hubs immobilize front axle gears and drive shafts for reduced wear, especially on tires.

bility. Some trails are too narrow, and in really rough terrain, the center skid plate and back bumper are frequently in ground contact.

Full-time four-wheel drive is a great help for those whose daily driving includes both on-highway and off-road conditions. It's automatic, except for low/high range, and locking of center differential.

Interior car space is vast. A big storage box (optional) was fitted between the bucket seats, and the glove box is of useful size.

The seats are comfortable, but rather low. Since the hood line is very high, the forward view is very poor. Interior finish is high-grade, with simulated wood-grain paneling in front and rear. Vent and air-conditioning outlets are built into the instrument panel. The floor is carpeted, doors have pockets. The rear seat has armrests and ashtrays.

We like the wide brake pedal used on automatic-transmission models. A pedal-type parking brake is standard. A hefty bar on the back of the right front seat releases it to tilt forward for access to the back seat.

The Blazer has surprisingly slow acceleration for V8 power, but it bested even the Wagoneer in quietness. Underhood accessibility is satisfactory. The engine compartment is uncommonly wide.

Ford Bronco. All-new in 1966, the Bronco has evolved in terms of options, and now you can get automatic transmission and power steering, but not power brakes or disk brakes. The four-wheel drive is conventional, controlled by a floor lever giving *2H, 4H, N,* and *4L.* You've got to stop the car to shift, and keep the automatic transmission in neutral; we found it the least satisfactory of the systems under test.

The Bronco is very noisy at highway speeds, and the ride is choppy and rough. Smallest in the group,

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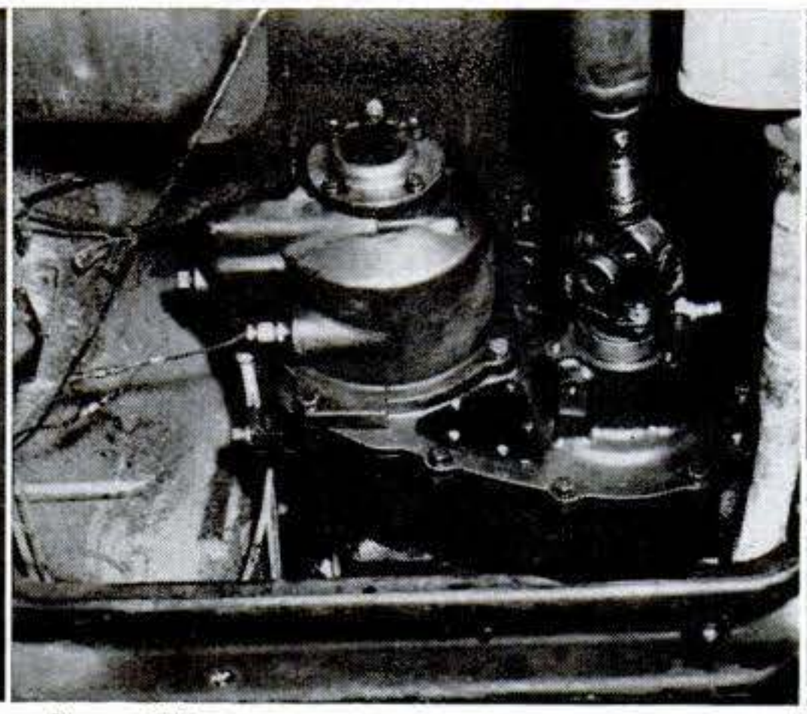
Blazer transfer control lever gives high and low range, enabling driver to lock center differential (between axles) for extra mobility on slippery ground.



Jeep Wagoneer transfer case is Borg-Warner with chain drive from transmission output shaft. Center differential is included, with lock switch in glove box.

Dash-mounted switch on Jeep is handy —pull out for low range, push in for high. Shifts are best made at standstill or when you're rolling slowly in neutral.

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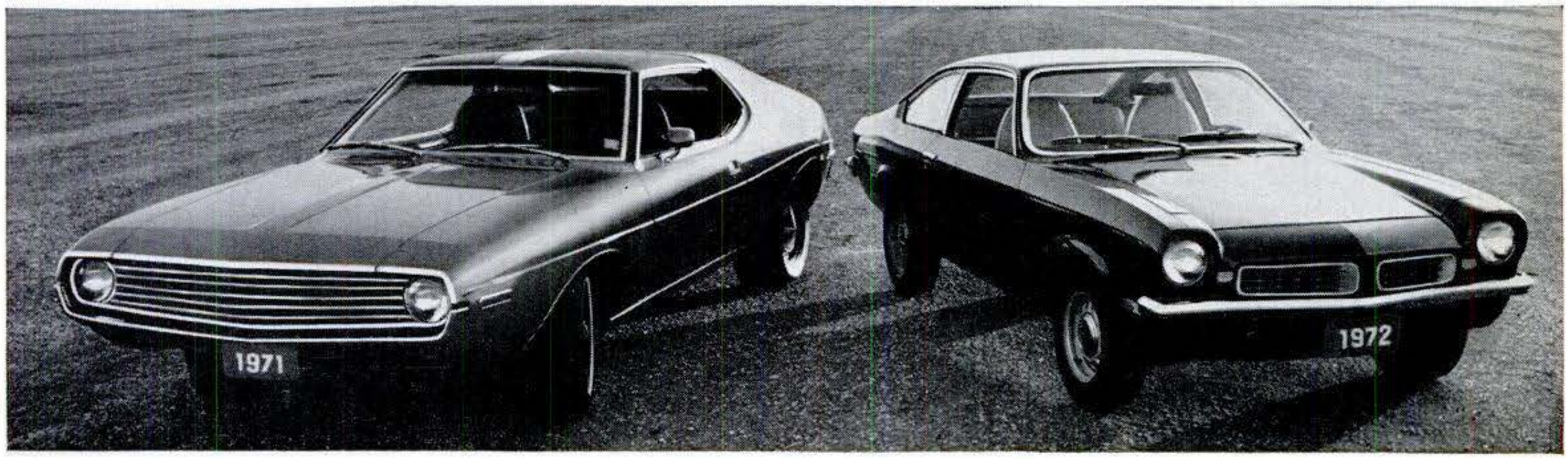
High compression. Low compression. Which is tougher on your oil?

Using high octane fuel, high compression engines generate high heat. Low compression engines using low octane and leaner fuel mixtures can run even hotter. And heat is the main reason motor oil deteriorates. Today you have to name your oil. By type. By SAE Grade. By brand.



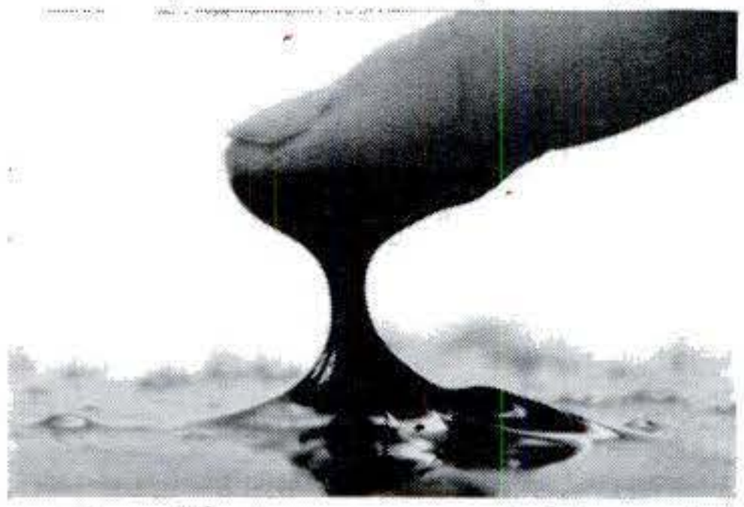
Recent governmental regulations aimed at controlling automotive emissions have resulted in the introduction of low lead fuels. These fuels, in turn, are made necessary by the advent of new catalytic reactors soon to be required on all cars. For these reasons, car makers have had to reduce the compression ratios of the new car engines. Here's why.

Refresher course on compression ratio. A high compression ratio (10.5:1 is typical) needs high octane gasoline, and a rich mixture of gas-to-air for good driveability. That way you get top performance... but a lot of unburned gasses are passed through the tailpipe into the environment.

A low compression ratio (9:1, for instance) can operate on lower octane gas and a leaner mixture of fuel that's compatible with emissions control systems. The results are more sedate performance and greatly reduced pollution. Plus one more thing: heat. Oil-killing heat.

How heat kills oil. As you know, oil gets thin when hot. But did you also know that oil can *thicken* under heat? The cause is oxidation. That is, oxygen molecules combine with "oil" molecules to make more complex molecules. Under high heat conditions over extended periods, the oil can become dangerously thick. In extreme cases, it can become almost jelly.

A thickened, oxidized oil loses its ability to flow easily through the



engine. That causes metal-to-metal contacts. And vital parts wear more and more. In severe cases they seize.

Two ways to fight back.

1. Change oil more frequently

Because you can't judge when oil oxidation has reached the danger point, your best protection is to change oil more frequently. Your owner's manual gives you recommendations for normal conditions. But please read the little notes of caution that usually accompany the recommendation. Dusty roads, stop-and-go driving, sustained high-speed driving, heavy loads, extreme temperatures are all conditions requiring more frequent changes. Also be sure you choose the right SAE Grade for your driving climate.

2. Know your motor oils.

Today you have to be specific about motor oil. You should use one that is refined from the best grade of crude oil—then scientifically blended, fortified and proven. There's too much at stake to put just any motor oil into your crankcase.

You should also know that "SE" is a designation for motor oil which meets the requirements for high temperature engine performance and is recognized by the Automotive and Petroleum Industries. We advise that *all* fully equipped cars use it.

Why Quaker State offers quality protection. There's one thing about Quaker State Motor Oil that few others offer. 100% Pure Pennsylvania Grade Crude Oil. The world's choicest.

Then Quaker State Motor Oil is fortified with a blend of additives, so you can be sure that it will keep its cleaning and lubricating powers even when the going is hottest.

Remember. Ask for this fine motor oil by name wherever they care about cars. Quaker State.

Quaker State your car to keep it running young.

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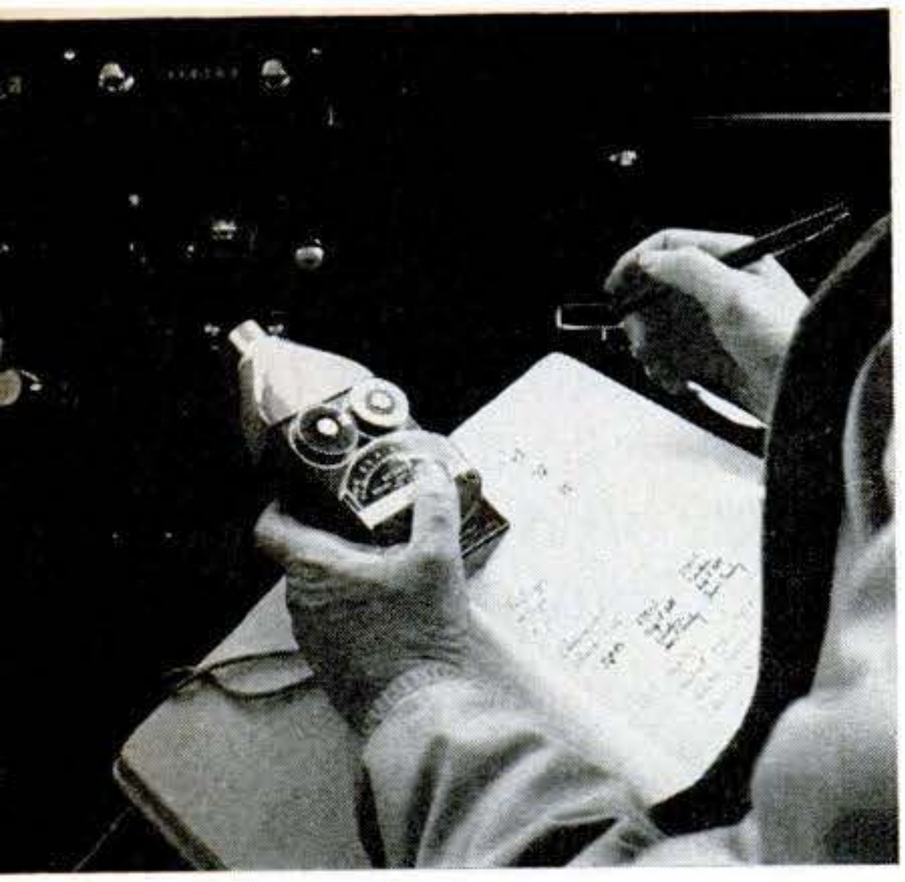
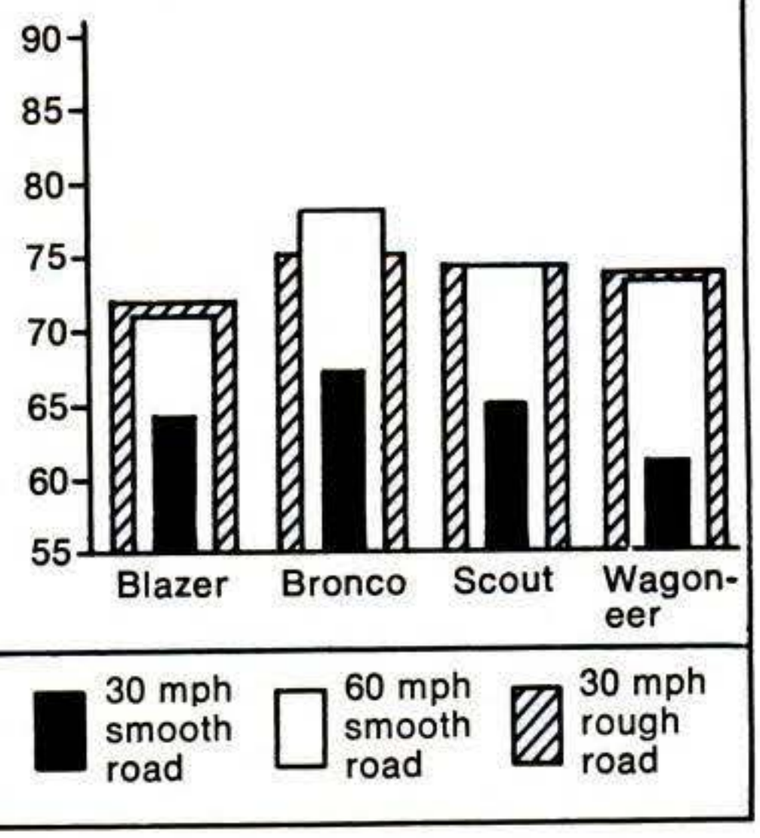


We test noise levels in car interior (see box at right) under these conditions: Dunne, above, holds sound-level meter near center of front seat and records readings in decibels on A-weighted scale, regarded as corresponding most closely to human ear's receptivity. It is also most suitable for nondirectional noise sources, giving equal importance to engine, road, and wind noise. Our tests have proved entirely consistent with full repeatability.

NOISE-LEVEL TESTS

Interior noise is measured in decibels on the A scale on our standard General Radio sound-level meter applied under three sets of conditions. A reading of 50-dbA is like an average residence. A 60-dbA reading is like a large store; 70-dbA, like a freight train going by 100 feet away; 80-dbA, like a pneumatic drill at 50 feet



the Bronco is at its best in rough terrain. It has excellent forward visibility over the stubby hood.

The standard gas tank holds only 12.7 gallons. We recommend the optional 7.5-gallon auxiliary tank. To switch from one tank to another, you turn a cock installed on the floor, at the front edge of the driver's seat. Flick a switch on the dashboard, and the gas gauge reads fuel level in the tank you've switched to. The brake pedal (same as on Broncos with manual transmission) is narrow.

To get to the back seat, you fold the front passenger seat in a two-stage motion. First the seat back swings out to the side, then the seat doubles over. The release, incredibly, is on the *left* side of the seat. The driver's seat can be folded the same way.

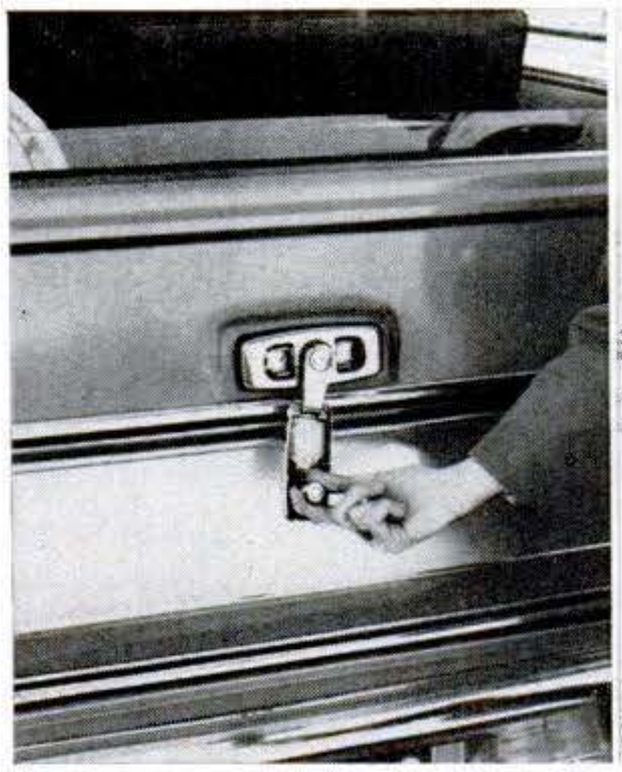
Performance is brisk, brakes adequate, handling poor, maneuverability very good. Engine-service accessibility is above average, with no special problems.

International Scout. This is an updated version of the Scout II,

Jeep rear seat folds up, giving 62.3 cu. ft. of cargo space (to ceiling height). With seat in place, there's 30 cu. ft. of "trunk" space below windowsill level.

Scout tailgate is two-piece design. Top, window area, swings up; bottom part folds down to form an extension platform for the floor. Back seat folds up, giving a maximum cargo space of 76 cu. ft. With rear seat in place, "trunk" space below rear windowsill level is 23.1 cu. ft. Spare wheel stands alongside left wall.

Bronco tailgate can't be opened until spare-wheel carrier has been swung aside. Maximum cargo space is 54.2 cu. ft. (with back seat removed), 11 with seat.



Blazer tailgate has wind-down window, folds down as platform. Maximum cargo space is 85.8 cu. ft. (to ceiling) with rear seat removed. With seat in place, you have a 13.5 cu. ft. "trunk" below windowsill level. Spare wheel, mounted on special bracket behind the back seat, steals much room, is not easily removed.

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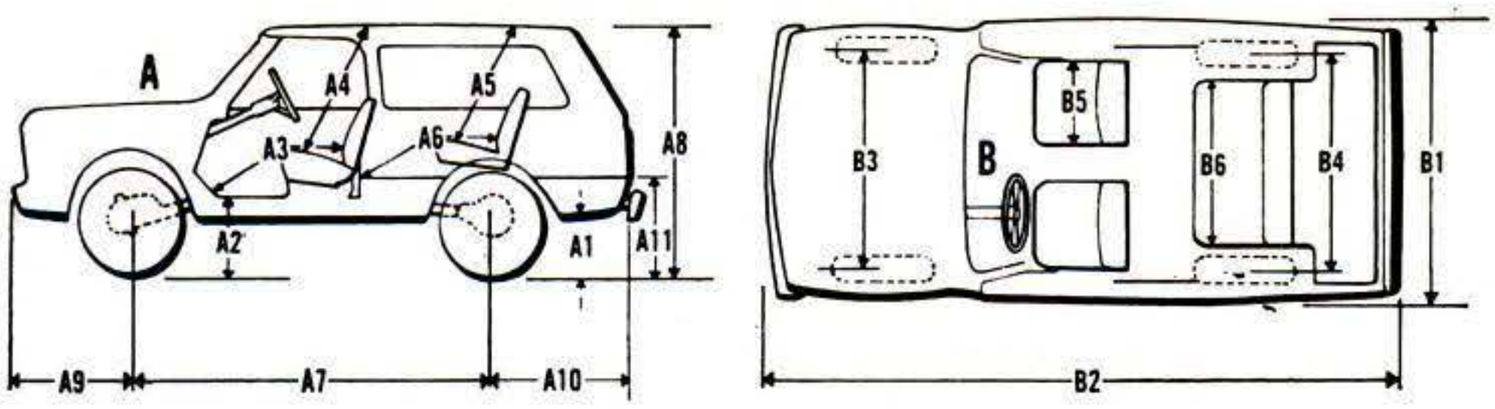


DIMENSIONS (inches)	Chevrolet K5 Blazer Cheyenne	Ford Bronco Explorer	International Scout	Jeep Wagoneer
A1 Ground clearance	7.3	6.6	7.7	7.75
A2 Step height	21.0	21.5	17.0	18.0
A3 Front leg room (max.)	42.5	44.0	44.0	44.0
A4 Front head room	41.0	39.0	39.0	39.2
A5 Rear head room	38.0	36.0	37.5	39.7
A6 Rear leg room (min.)	45.5	39.0	42.0	39.4
A7 Wheelbase	106.5	92.0	100.0	110.0
A8 Height	72.8	70.7	66.4	65.3
A9 Front overhang	36.75	26.9	24.0	28.7
A10 Rear overhang	41.75	33.2	41.8	45.0
A11 Rear load height	31.0	29.5	22.7	26.5
B1 Width	79.0	68.8	70.0	75.6
B2 Length	185.0	152.1	165.8	183.7
B3 Front track	64.0	57.4	57.1	57.3
B4 Rear track	62.5	57.4	57.1	57.5
B5 Front hip room	62.0	55.0	52.0	56.5
B6 Rear hip room	49.0	36.0	52.0	54.5
SPECIFICATIONS				
Engine type	OHV V8	OHV V8	OHV V8	OHV V8
Displacement (cu. in./cc)	350/5738	302/4921	345/5656	360/5902
Compression ratio	8.5:1	8.0:1	8.05:1	8.5:1
Carburetion	one 2-bbl.	one 2-bbl.	one 2-bbl.	one 2-bbl.
Net hp @ rpm	175 @ 4000	139 @ 3800	144 @ 3600	175 @ 4000
Net torque @ rpm	260 @ 2800	232 @ 2600	263 @ 2000	285 @ 2400
Transmission	automatic w. 2-speed transfer case + full time 4wd	automatic w. 2-speed transfer case + manual 4wd	automatic w. 1-speed transfer case + manual 4 wd	automatic w. 2-speed transfer case + full time 4 wd
Front axle ratio	3.31:1	3.54:1	3.31:1	3.31:1
Rear axle ratio	3.21:1	3.50:1	3.31:1	3.31:1
Tire make	Firestone	Firestone	Firestone	Goodyear
Tire type	Sup R belt	Sup R belt	Belted Gripper	Polyglas
Tire size	178-15	G78-15	H78-15	H78-15
Steering	power	power	power	power
Turns (lock to lock)	4.25	5.75	4.25	4.33
Turn diameter	39	33.6	34.8	44.4
Brakes	power	manual	power	power
Brake type	disk/drum	drum/drum	drum/drum	drum/drum
Disk diameter	11.0	—	—	—
Drum diameter	10.0	F.11 R.10	11.0	11.0
Swept area (sq. in.)	348.0	295.3	259.2	276.45
Fuel tank (gal.)	24.0	12.7 + 7.5 reserve	19.0	22.0
Angle of approach	33.5°	40.6°	43.0°	39.0°
Angle of departure	23.5°	27.2°	23.0°	20.0°
Curb weight (lbs.)	4088	3455	3918	4110
F/R weight distribution (%)	56.2/43.8	57.4/42.6	57.3/42.7	55.5/44.5
Price (basic)	$3341.25	$3588	$3422	$4640
Price (as tested)	$5796.90	$4495	$5270	$5709
TEST RESULTS				
Acceleration 0-60 mph	22.5	15.05	16.4	16.0
Acceleration 0-80 mph	44.5	38.3	36.65	31.5
Acceleration 25-70 mph	28.25	19.25	23.7	19.05
Braking (cool) 60-0 mph	130.3	171.4	154.3	135.5
Pedal pressure	60 lbs.	90 lbs.	80 lbs.	60 lbs.
Braking (hot) 60-0 mph	163.75	179.5	195.3	155
Pedal pressure	200+ lbs.	200+ lbs.	200+ lbs.	85 lbs.
Handling test (mph)	56.3	53.0	60.0	56.3
Maneuverability (mph)	25.0	25.7	24.6	24.6
Gas mileage 45 mph (mpg)	9.648	11.145	11.760	11.760

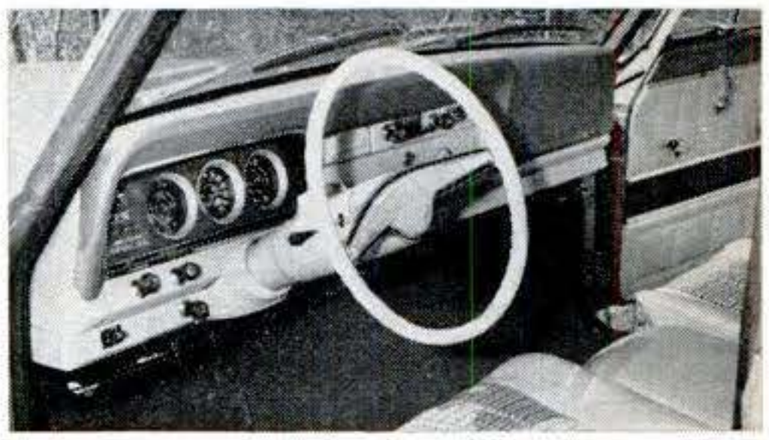
TEST CONDITIONS: Ambient temperature, 49°F; humidity, 53%; barometric pressure, 30.1 in.

How other vehicles have fared in our tests

TESTS	CHEVROLET Blazer '71	FORD Baja Bronco	INTERNAT'L Scout II	JEEP Wagoneer '71	JEEPSTER Commando	JEEP Universal	LAND ROVER	TOYOTA Land Cruiser	VOLKSWAGEN Microbus	CHEVROLET Sport Van	DODGE Sportsman	FORD Club Wagon
Accel. 0-60	17.85	15.35	14.2	15.05	13.6	11.0	39.0	30.6	38.0	17.2	13.9	15.3
Accel. 0-80	36.0	32.4	32.0	32.1	32.0	29.8	—	—	—	34.9	30.4	32.4
Accel. 25-70	21.2	18.6	18.8	20.0	18.1	14.0	—	31.5	—	22.4	16.85	19.75
Braking 60-0 (hot)	162.1	252.8	336.0	241.0	164.3	154.0	130.0	196.0	155.3	201.3	146.6	180.0
Handling test	49.9	56.3	53.0	49.9	57.5	56.3	53.0	57.5	48.0	51.3	48.5	49.9
Maneuverability	25.0	25.7	23.6	22.7	26.0	27.6	26.0	25.7	26.0	23.3	23.3	24.6
MPG (45 mph)	12.7	12.7	14.7	14.6	12.2	11.0	15.5	13.2	18.6	11.2	10.2	9.8
Noise (60 mph)	78dbA	82dbA	82dbA	75dbA	—	—	—	—	—	—	—	—
Price	$4577	$6882	$3880	$5946	$3988	$3049	$3536	$3289	$2885	$4323	$4267	$4733

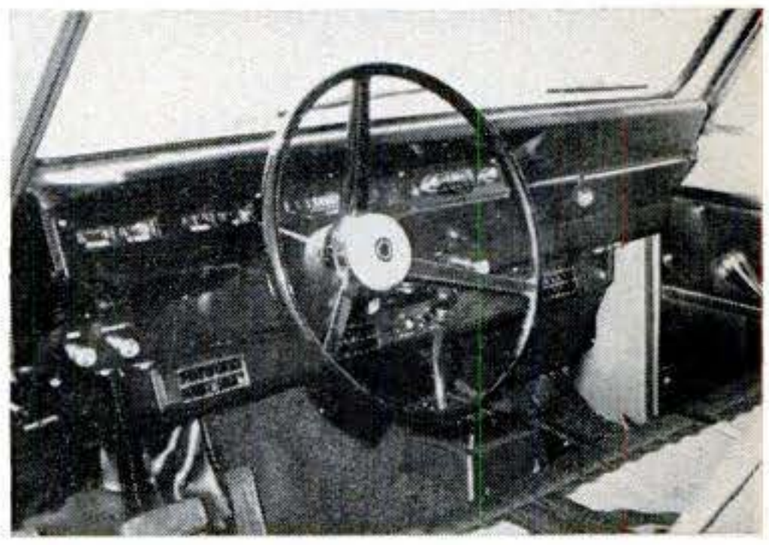
which was all-new in 1971. Our test car was equipped with the latest drive-train option—a single-speed chain-drive transfer case with the drive to the front axle engaged or disengaged by a little pull/push handle under the dashboard. Pull to get four-wheel drive, push for rear-wheel

[Continued on page 125]



New AMC-type instrument panel on the Wagoneer holds gauges for fuel, temp, oil, and amps. Pedal parking brake is standard. There's no inside hood lock.

Bronco's small gauges—oil, battery, temp, fuel, around speedometer—are difficult to read. Surprisingly, light and wiper switches are at the driver's right.



Scout's horizontally grouped gauges sit high, in excellent reading position. Well-placed trucker-size knobs, door handles, shift lever impress with quality.

Blazer's superb instrumentation: tach, speedo, oil, temp, bat, and fuel gauges. Interior hardware and finish are passenger-car type. Car had tilt-wheel option.

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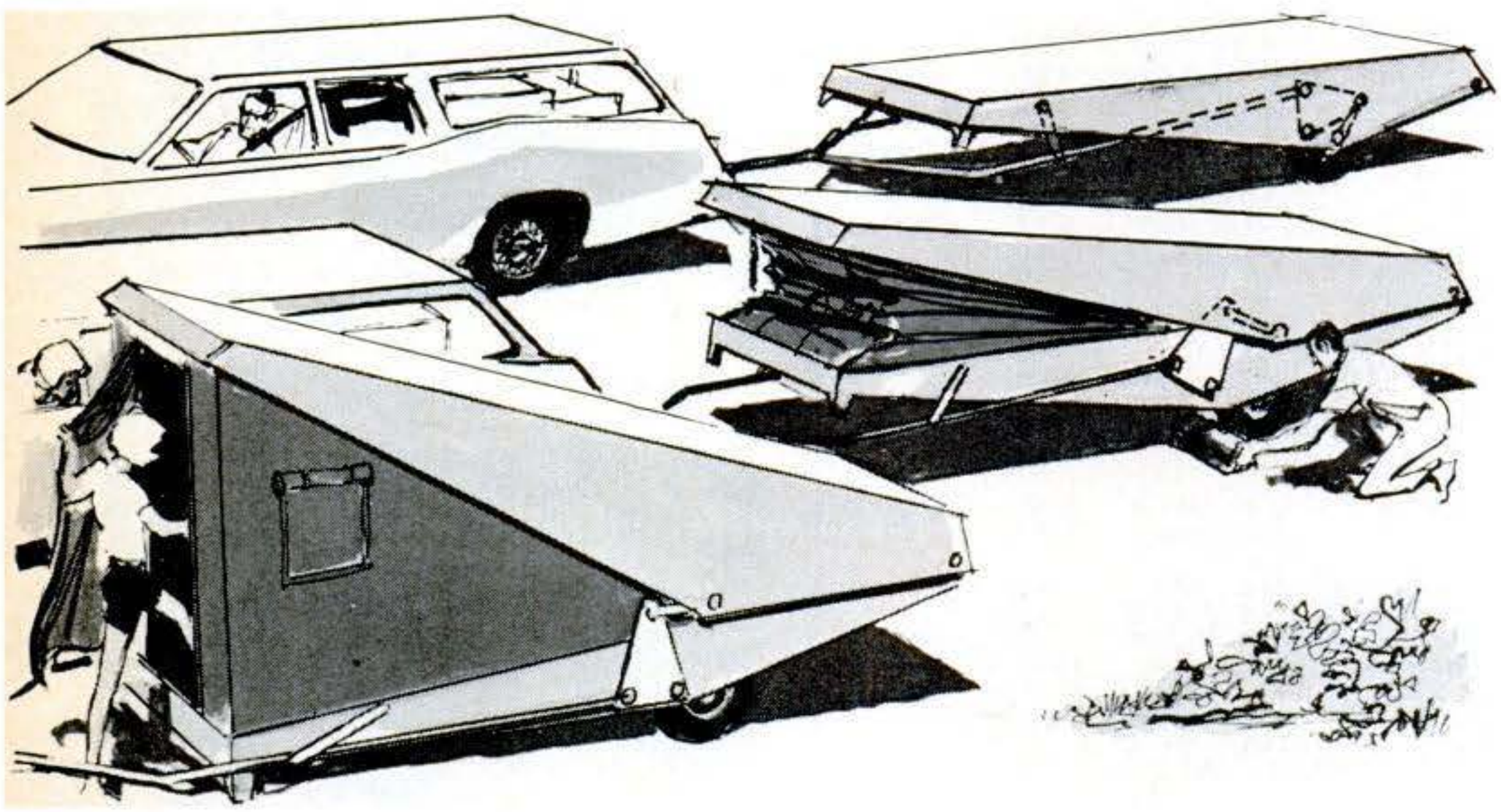
New Ideas from the Inventors

The PS pick of ingenious inventions recently patented

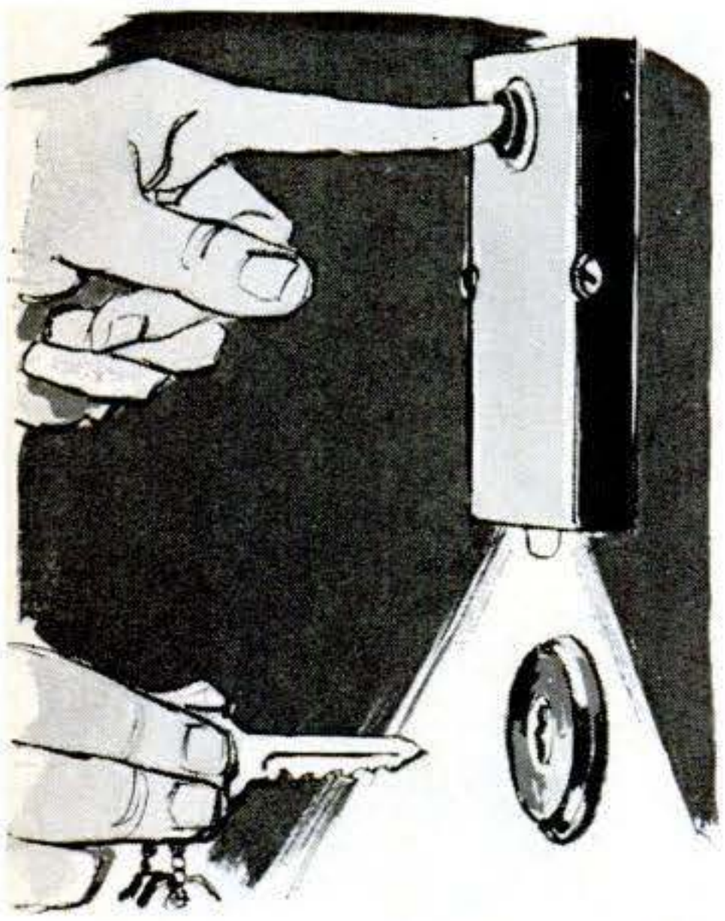
ILLUSTRATIONS BY DANA RASMUSSEN



Drawbar linkage tilts and opens clamshell trailer

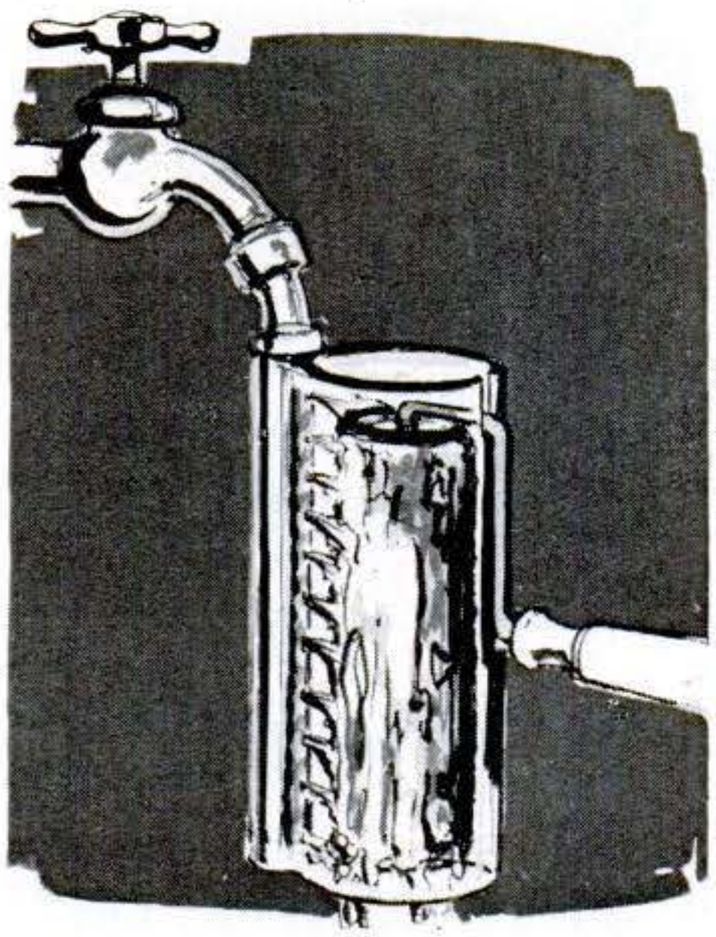
Hinges linked to the drawbar of this camper trailer would let you tilt the floor down and the roof up by pulling against blocked wheels. When opened, the front walls—and door—would unfold from travel position to enclose the expanded room space. Closed up, the trailer would travel low to the ground and would give the driver a full, unobstructed rear view. With hinges reversed, the clamshell-type trailer could be made to tilt and open to the rear for easier loading and hauling of heavy or bulky equipment.

Door light lights keyhole



Mounted on a door frame, this battery-powered illuminator would help you find the right key in the dark and insert it in the lock. Its touch-button switch would be held closed by a surrounding vacuum cup designed to keep the light on for a short time. As the vacuum seal relaxed, the light would turn off.

Faucet coupling rinses roller



Rollers used in water-base paints might be washed more thoroughly in a dual-tube, running-water cleaner like this. With one cylinder coupled to a faucet, water would spray through connecting holes into the second, roller-enclosing tube. After swirling around the roller, the water would drain out the bottom.

Light meter straps on wrist

A photographer wouldn't need an extra hand to take a light reading if he wore a two-part meter like this. When he raised his arm, the photocell attached to one side of his wrist strap would face the subject and the indicator dial on the other side of the strap would face him. The standard photocell and dial elements would be connected to each other by wires running through the flexible, watch-type strap.

Boat step eases boarding

Hooked over the stern or gunwale of a boat, this partly submerged boarding platform would steady itself against the boat's side. It would let a swimmer slide aboard, unload diving gear if necessary, then simply stand up and step onto the deck. Straps supporting the inboard and outboard ends of the platform could be adjusted to level the step. When not in use, the canvas boarder would fold up for storage.

The following patents have been issued on these inventions:

Clamshell trailer—*No. 3,591,230 to G. F. Cramer, Nashville, Ind.;* **Keyhole light**—*No. 3,590,234 to A. M. Bartick, Anaheim, Calif.;* **Paint-roller cleaner**—*No. 3,577,280 to R. W. George, Minneapolis;* **Strap-on light meter**—*No. 3,589,818 to H. Mountain, Detroit;* **Boat-boarding step**—*No. 3,587,123 to T. W. O'Boyle, Constantia, N. Y.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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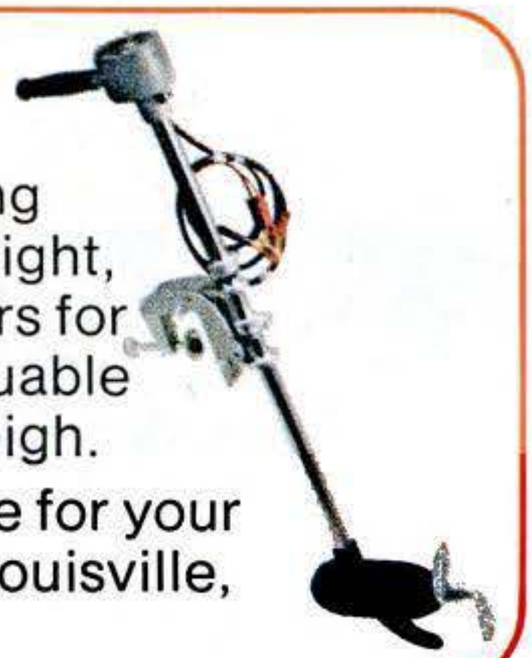

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Filter Kings, 16 mg. "tar," 1.2 mg. nicotine; Longs, 18 mg. "tar," 1.3 mg. nicotine, av. per cigarette, FTC Report February '73

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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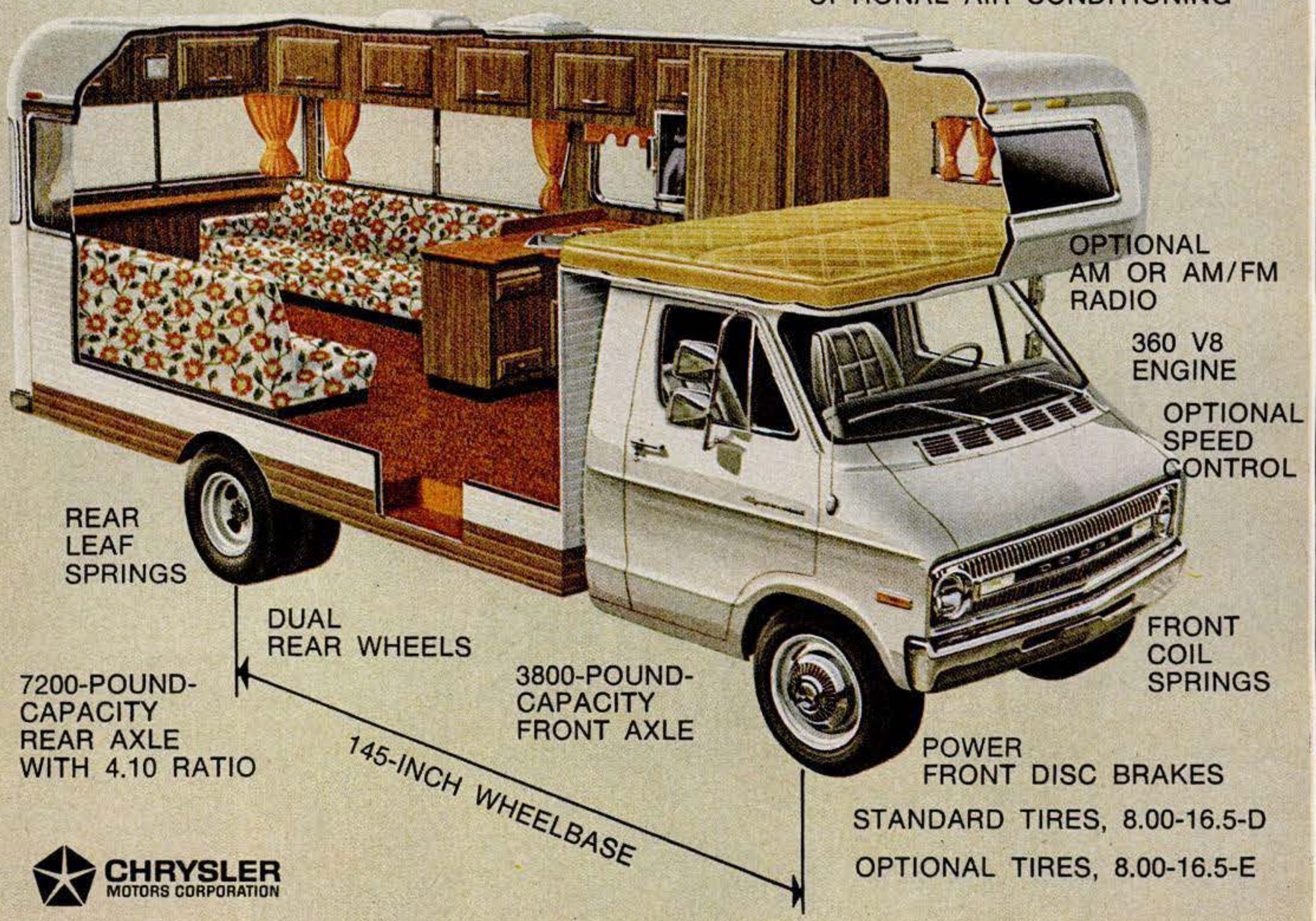
Dodge introduces the longest van chassis in the business so you can ride in the roomiest mini motor homes on wheels.

Extra room for storage and camping comfort can be yours with the new chassis from Dodge. Innovative Dodge engineering gives you these new features that can be underneath your mini motor home. The 145-inch wheelbase. No one else has it. And it comes with dual rear wheels, 360 V8, 10,000-pound GVW, power steering, automatic transmission, and Electronic Ignition System. What happens when imagination takes over? The same old thing. Progress.

Dodge
Dodge Trucks



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Turn to Dodge for leadership in Recreational Vehicles

FOR LEADERSHIP IN R.V.'S...
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PS: What's News...

Keeping You Posted from Behind the Scenes

Scientists who concern themselves with the fundamentals underlying the human condition will argue that the ability to communicate is the most significant characteristic distinguishing man from other animals. Particularly, they say, the facility of communicating with other beings not in the immediate presence of the communicator is the engine powering the development of human societies. From crude drawings scratched on a cave wall, to the written word, to TV pictures from the moon, the thrust of communications technology is to let everyone know what anyone knows. And the faster knowledge is spread, the quicker problems are solved.

This little excursion into philosophy brings us to the subject of this month's cover story. The telephone handset you see in the cover picture stretches modern communications technology for the consumer to the limits of present-day know-how. Spurred by the decision of the FCC to open a band of frequencies in the uhf region just above the TV range, and an invitation to manufacturers to submit proposals for the best use of the new band, Motorola developed this totally new concept for on-the-go communications. The demand for the new service is evident to anyone who has tried to subscribe to the present mobile telephone service—there are long waiting lists in every major city, even for those like doctors, entitled to high priority. Associate Editor John Free flew to Motorola's Communications Division in Chicago to get the technical details and tells you all about this latest communication marvel in the article beginning on page 60.

The Jetfoils are coming

Contracts have been signed for the purchase of four more of the huge hydrofoil ships we described in our April issue ["Jumbo Jetfoil Will Be Superfast, Super-Smooth"]. A Hawaiian firm, Pacific Sea Transportation, Ltd., has purchased three of the Boeing-built, 106-ton vessels for passenger service among the Hawaiian Islands beginning in late 1974. The total price is about $14 million. One was also bought by Marianas Jetfoil, Inc., of Guam to begin service in 1975.

Mr. Piper and his Cubs

If you have no interest in private flying, you can skip this. I don't often use this space to review books, but I feel I would be remiss if I didn't let you know about one I've just read. *Mr. Piper and His Cubs*, published by Iowa State University Press, is an absorbing story of the man and the machine that did for private flying what Henry and the Model T did for automobile travel in this country. The Piper Cub became almost synonymous with private flying in the U.S. during the '30s, '40s, and '50s. With lively anecdote, a wealth of detail, and the sure hand of one who knows his subject intimately, the author, Devon Francis (a former senior editor of PS) grabs your interest from the first page with the story of the man who entered the aircraft business almost by accident. Mr. Piper couldn't even fly an airplane, much less build one, when he started with a $400 investment. The people associated with the enterprise over the years are as fascinating as the flying machines they built. Both are the heroes of Mr. Francis' story.

Metric changeover

More than any Congressional committee recommendations, the recent announcement from General Motors that their new Wankel engine will be measured in meters, grams, and liters surely marks the beginning of the end of the awkward English system of measurement in this country. The nation's largest manufacturer said it has decided to switch to the metric system for all new products. With the giant auto maker going metric, no machine tool manufacturer can afford to resist the switch. GM buys parts, equipment and services from about 40,000 other companies. If the machine-tool makers switch, other car companies and vehicle manufacturers cannot afford to lag behind. This makes a pretty big snowball to start the whole country rolling toward metrification.

Sun eclipse observation at supersonic speed

On June 30, scientists from Britain, France, and U.S. will follow the path of the moon's shadow across the earth in the supersonic Concorde 001 [PS, July '70; Apr. '72]. They'll be in the moon's shadow for 80 minutes, giving them 11 times as long to conduct their experiments as they would have on the ground. The flight will start from Las Palmas, Canary Islands, joining the eclipse path in Mauritania, West Africa, at 10:45 GMT (Universal Time). They will fly 1900 miles east along the eclipse path at an altitude of 60,000 feet, well above the infrared absorbing layers of the atmosphere. To allow observation, special windows are being fitted in the roof of the Concorde. Five experiments will be carried out during the flight.

Toward a total national energy policy

Recent reports from the Energy Policy Project indicate that we are finally getting serious about a multifaceted approach to our energy dilemma. You can get a fair idea about the breadth and depth of the overall problem just by reading the nature of the studies and research projects that have received funds: The University of Michigan got a grant to investigate how much energy is needed to clean up the environment; a grant to the University of Illinois will help support a study of the relative energy costs of various consumer purchases; Princeton University got funds to study the energy implications of various transportation alternatives; the American Public Health Association will study the health effects associated with the use and production of energy. Some 17 other major outside studies have also been funded ranging from a study of how to mine Western coal without damaging the environment to changes needed in architectural design to better conserve energy.

Hubert P. Luckett
Editor-in-Chief

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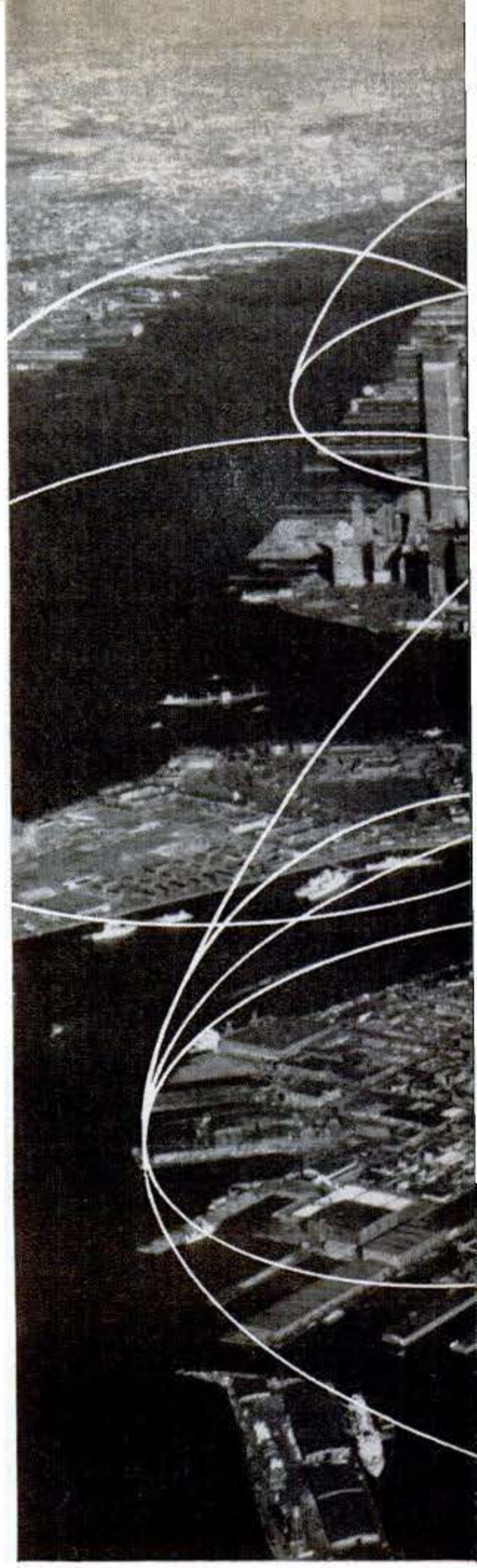
Fishing offshore, driving home from work, or riding horseback — this phone user could place and receive calls anywhere with new system planned by Motorola. Photo at right shows coverage of New York area for transmitters (large domes) and receivers (small domes) to handle calls to and from portable phones. Citywide network would funnel calls through a computerized central station. Central computer could tie portables into telephone exchange.

Photo Courtesy of N.Y. Port Authority



New Take-Along Telephones Give You Pushbutton Calling to Any Number

This amazing phone system could handle thousands of calls simultaneously, patching yours directly into a phone exchange

By JOHN R. FREE ILLUSTRATIONS BY THIBAULT/BUONOCORE STUDIOS

Minicomputer used to track and switch Dynatac calls is described to author by project engineers, right. Computer directs calls into phone exchange.

The caller pushed the portable phone's OFF-HOOK button. For a split second, the telephone—a new type of computerized, walkie-talkie-size portable—"chatted" inaudibly with a minicomputer in another building. Then I heard a familiar dial tone, and the caller tapped the pushbutton keyboard, placing a call around the world to Australia.

Motorola's Communications Division was demonstrating its Dynatac phone system in a New York Hilton penthouse suite. For each call, the portable was tied directly into a telephone exchange several blocks away over an ultra-high-frequency (uhf) radio signal. Dynatac bypasses the mobile-telephone operators required to place calls with conventional mobile and portable phones.

With Federal Communications Commission approval, the first Dynatac system may be operating in New York by 1976. Using untapped frequencies above 900 mHz, it would use a complex computer-controlled transmitter and receiver network (as in photo and drawings) for thousands of simultaneous on-the-go calls. Today's badly overcrowded radio-telephone bands (450 mHz and below) are limited to a few dozen calls at one time in major cities.

"In a city where the Dynatac system is installed," says John Mitchell, division general manager, "it will be possible to make telephone calls while riding in a taxi, walking down the city's streets, sitting in a restaurant, or anywhere else a radio signal can reach.

"We expect there'll be heavy usage by widely diverse groups—businessmen, journalists, doctors, housewives—virtually anyone who needs or wants telephone communications in areas where conventional telephones are unavailable," Mitchell said. You would not need a license to operate a portable, but would lease it from a common carrier—Motorola, a phone or radio company.

To find out how Dynatac works,

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I visited Motorola's sprawling plant near Chicago where the company produces a variety of communications gear. Martin Cooper, director of systems operations, first described the new solid-state technology required for the 45-ounce portable, then explained how the computer-controlled transmitters and receivers would function.

New uhf circuits. "Getting up to 1000 mHz is pushing everyone's state of the art," Cooper said. So far, the 900-1000-mHz uhf region has been used for point-to-point applications such as traffic-light control. Opening the band for land mobile communications, first proposed by the FCC in 1970, now requires new uhf semiconductors that will operate efficiently at low battery voltages. Manufacturers are just introducing integrated circuits with the ultrafine chip structures needed for uhf.

Using these new ICs, the portable's 14-volt battery powers the

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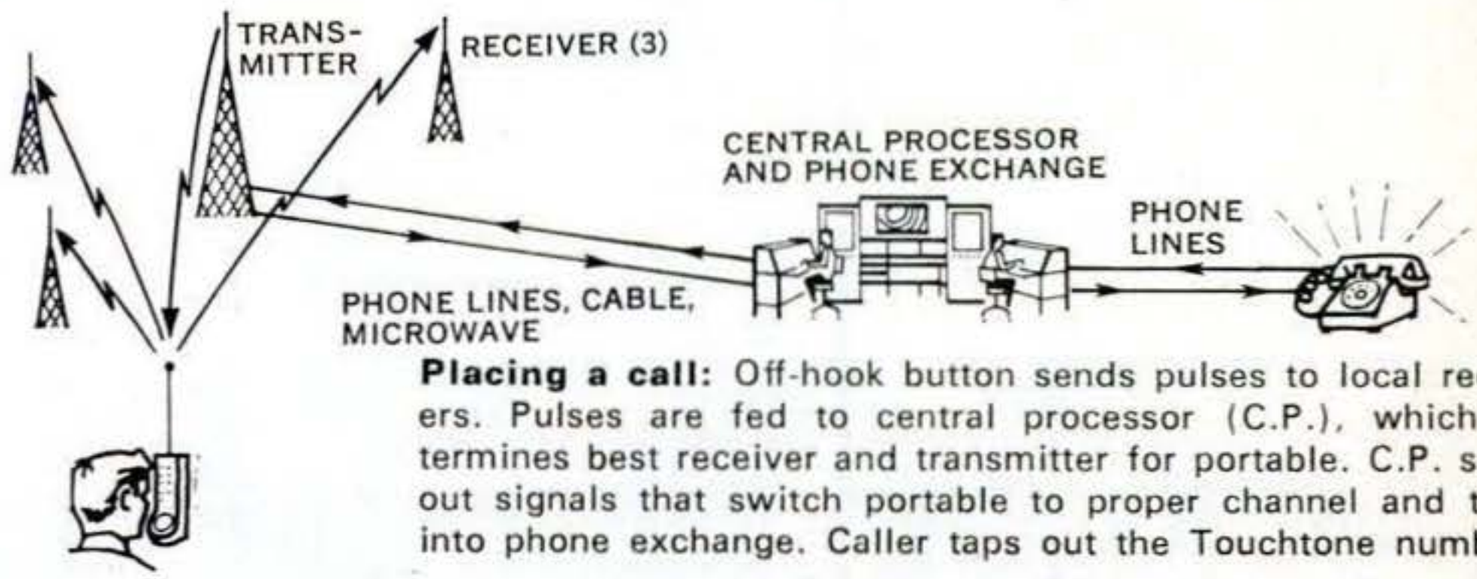
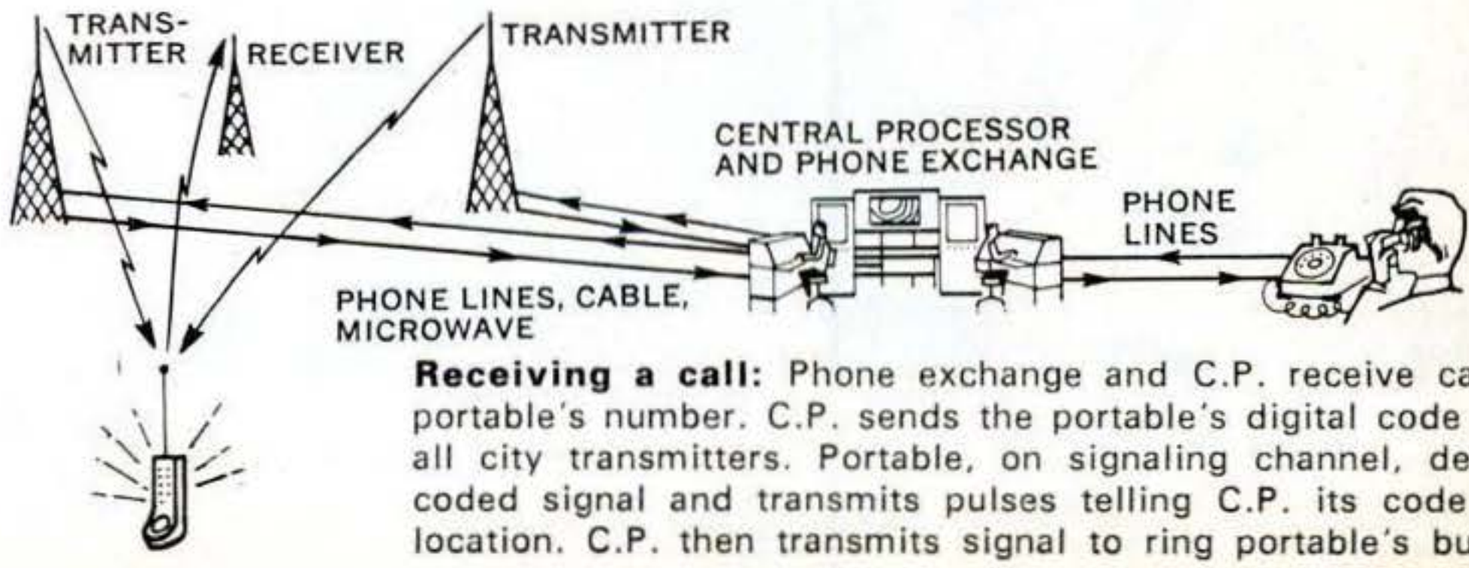


Placing a call: Off-hook button sends pulses to local receivers. Pulses are fed to central processor (C.P.), which determines best receiver and transmitter for portable. C.P. sends out signals that switch portable to proper channel and tie it into phone exchange. Caller taps out the Touchtone number.



Receiving a call: Phone exchange and C.P. receive call to portable's number. C.P. sends the portable's digital code over all city transmitters. Portable, on signaling channel, detects coded signal and transmits pulses telling C.P. its code and location. C.P. then transmits signal to ring portable's buzzer.

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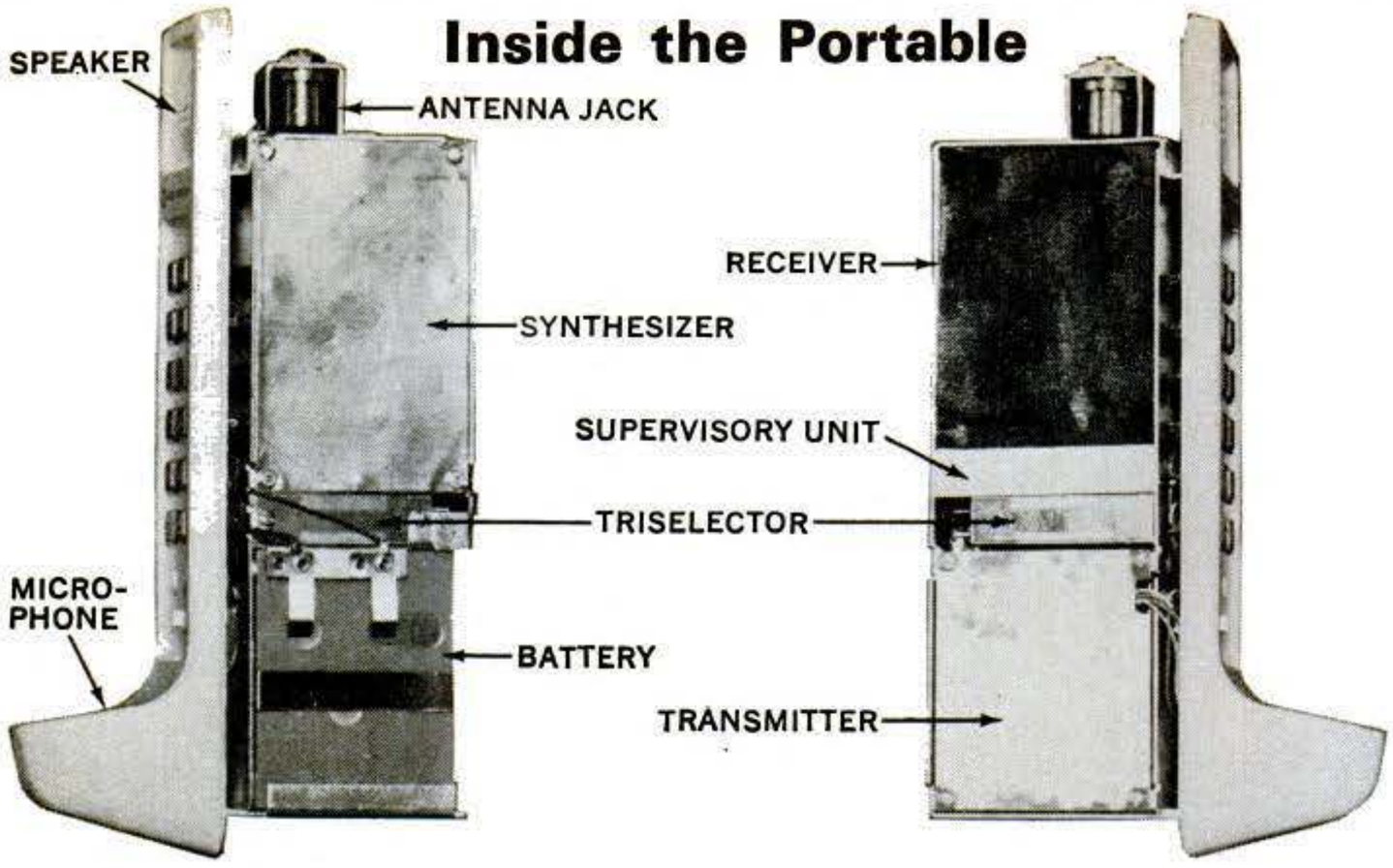


Circuits in the portable are isolated from each other by soldered sheet metal to prevent uhf interference. The eight-chip synthesizer generates 380 channels electronically. The triselector is a series of transmission lines for front-end tuned circuits and the duplex function (see text). The 14-volt ni-cad battery delivers power for 36 minutes of transmission. The two-chip supervisory section is the brain of the portable. It receives and sends digital signals to central computers. The transmitter is a one-watt custom linear IC. Squeezed into other parts of the chassis: Touchtone, AOC and VOX (see text), ringing and display circuits. The unit measures 1⅞ by 3½ by 9 in. and weighs 45 ounces. The flexible antenna is cut for the 900-mHz uhf band. Antenna gain is superior to quarter-wave whip designs.

one-watt uhf transmitter for 12 three-minute calls, and provides 12 hours of standby reception for incoming calls.

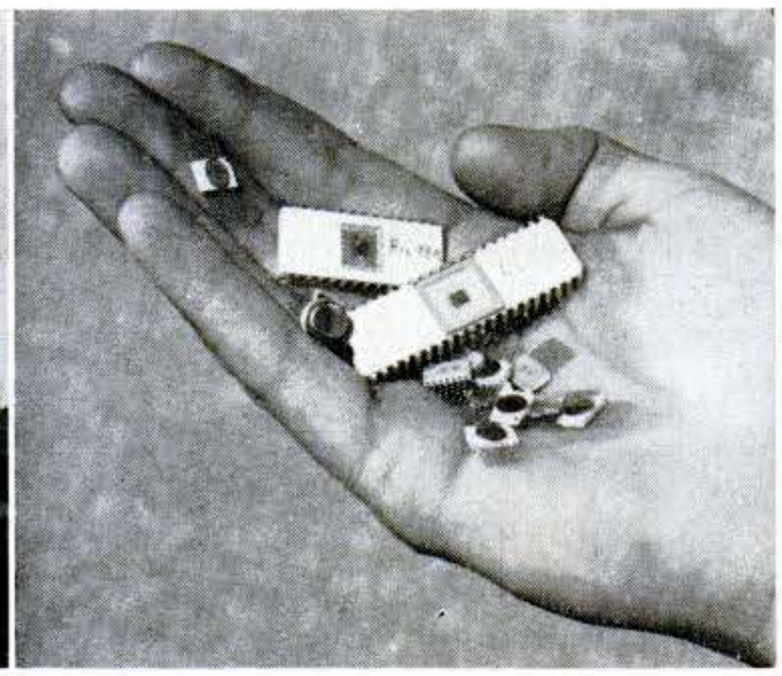
FM communication over Dynatac is duplex with VOX (voice-operated transmission). Duplex means you can talk and listen at the same time, in contrast to press-to-talk mikes on private-dispatch and military radios. When you transmit, an LED (light-emitting diode) on the portable glows.

Most of the portable's complex circuitry is used to generate 380 transmission channels and "talk" in binary computer language with central-processor computers. Fourteen LSI (large-scale integration) circuits, containing some 3000 transistors, are used for these functions.

Urban areas where Dynatac will be used are notorious for severe RF interference from vehicles, fluorescent lighting, and other sources. "We have to be concerned about an ignition pulse knocking out a bunch of data," says Cooper. "What you're looking for is the optimum way of plowing through this interference."

The electronic chitchat between the portable and central processor, which goes on inaudibly even while you're talking, is relatively immune to interference. The key is redundancy—extra bits of digital information beamed over the air. Losing some bits won't destroy a message.

Motorola's Martin Cooper, left, outlines proposed coverage of New York by radiophone system that may be in use by '76. System can handle thousands of calls.



Handful of 14 digital LSI packages used in prototype portable contains some 3000 transistors. Most LSI chips were specially designed for the portable.

Here's how the transmitter and receiver network would be set up: Transmitters, each surrounded by several receivers, would be strategically located throughout a city. The range of each 16-watt transmitter will correspond to the area's population density and expected phone use by subscribers.

Coverage and population. In super-dense Manhattan, for example, a transmitter and its antenna may be designed to cover a 15-block area. Another transmitter in a residential Brooklyn area may cover several miles. As the number of subscribers grows, more transmitters would be added. The range of existing transmitters would then have to be reduced. Numerous receivers are required because the portable's output is low (one watt).

Although Dynatac would use only 380 channels, through *geographic reuse* thousands of simultaneous calls and some 200,000 subscribers are possible (not everyone telephones at once). This means a caller in one part of the city would be using one channel while others use the same channel in nearby areas.

To avoid interference, the central processor would assign the same frequency to every third transmitter. A channel might be used simultaneously by 40 callers in later, high-density stages of Dynatac.

To understand how the portable operates with the central processor, let's trace a call from start to finish:

Making your call. When you push the OFF-HOOK button the portable is sitting on a signaling channel. The portable's supervisory section (see photos) sends a stream of digital data from the transmitter.

Several nearby receivers pick up the data, and send it by telephone wire, microwave, or cable to the central-processor station. There, minicomputers sense which signal is strongest and select the best receiver and transmitter for your call. A burst of data from the central processor is beamed from a nearby transmitter to your portable.

This data tells the supervisory section which talking channel the synthesizer section should electronically generate. Now the central processor ties you into a telephone exchange and you hear a dial tone. The portable is then used like a cradle pushbutton telephone.

"We'll probably have several sites near telephone exchanges with a trunk going in; one pair of wires for every customer," says Cooper.

If you travel through the city while telephoning, the central processor will sense changes in your

[Continued on page 130]

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For Shooters:

Three New Firearms

By PAUL WAHL

Lever-action .30-30 bows in

I've just range-tested a new .30-30 lever action, the Mossberg Model 472, that will give the old-timers some tough competition. It matches their on-target performance, looks, and good handling, but has important new safety features of its own.

Integral lever and trigger travel together, eliminating the possibility of accidental firing caused by the closing lever jamming your finger against the trigger. With its disconnecting trigger, the rifle cannot be fired until the action is closed and trigger released, and then pressure reapplied. A hammer-block safety lets you unload the magazine (operating the lever to eject unfired rounds) without danger of inadvertent discharge.

This seven-shot .30-30 carbine has a 20-in. barrel, is 38½ in. long, weighs 7¼ pounds. Price: about $115.

Little Favorite looks like grandpa's

A look-alike of your grandpa's Stevens Favorite (made 1894-1935), this handy little single-shot .22 rifle, the Savage Model 74, is a lot of fun to shoot.

It has a lever-operated falling-block action. The hammer must be manually cocked for each shot—a good safety feature for novices. Chambered for .22 Long Rifle, Long or Short, it has a 22-in. barrel, is 37 in. long, weighs 4¾ pounds. For a youngster's first rifle, the "Little Favorite" at $44.50 is a fine choice.

Over-and-under U.S.-made shotgun

There are lots of over-and-under shotguns on the market. Some even have American names. But they're made abroad—all except one, the new Remington Model 3200.

Right down to the pointing dogs engraved on the frame, the Model 3200 is the image of Remington's old Model 32. Like its ancestor, the 3200 is slim and graceful in profile, and beautifully balanced. I've never shot a better handling over-and-under.

The Model 3200 has the same separated barrels that keep their cool and point of impact better than the solidly joined kind. Retained, too, is the sliding top lock, which also shields the entire breech. Unlike the Model 32, however, the new gun has extra-strong side lugs that lock the barrels to the frame. A newly designed three-position barrel selector and safety lets you instantly choose the firing order by flicking it right or left from the central "safe" position.

Many O/U guns have inertia fire control, which uses the recoil from the first shot to cock the hammer for the second. With the Model 3200's mechanical fire control, the second barrel will shoot no matter what happened in the first barrel.

Lock time of 1.4 to 1.8 milliseconds is so fast that the shot is out of the Model 3200's barrel before it even pops the shell crimp in most other guns.

Weights range from 7¾ to 8¼ pounds, depending on barrel length and stock style (field, skeet, trap). Prices: field, $450; skeet, $470; trap, $490; special trap, $540; One-of-1000 trap, $1050. PS

Lever-action .30-30 made by Mossberg (left), and Little Favorite, by Savage, are two new rifles with good safety features.

Brand-new Remington 3200 is the best-handling over-and-under shotgun author ever tested, and it's made in the U.S.

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CAMARO gets a sloping front end, integrated with bumper. Front bumper is stronger—built to resist five-mph impacts even at odd angles. All models will have uniform-height bumpers.

VEGA gets a sneaky-looking new front end. Wasn't it to run five years without change? Yes. But the bumper law forced a redesign on Chevy, and the stylists took advantage of it.

TORINO gets fresh front-end dress-up with the new bumper. Same body will be used for Mercury Montego and for Cougar (which will lose its sporty-car body shell and convertible).

CHEVELLE had an all-new body for '73, but the grille is new for '74. The Chevrolet stylists must have been looking hard at the new Mercedes-Benz grille, intentionally or not.

The '74 Cars: More Changes

MONACO from Dodge changes its front-end design for '74. Front-suspension torsion bars are splayed, front track is wider. New sound-insulation package improves interior quiet.

IMPERIAL shares the new big Chrysler body, but sports its own unique nose. It's designed to be less aggressive toward pedestrians, and to distinguish the top-of-the-line model.

NEW YORKER by Chrysler has all-new sheet metal, with the same underbody and chassis as Imperial, Dodge Monaco, and Plymouth Fury. The same engineering changes are also applied here.

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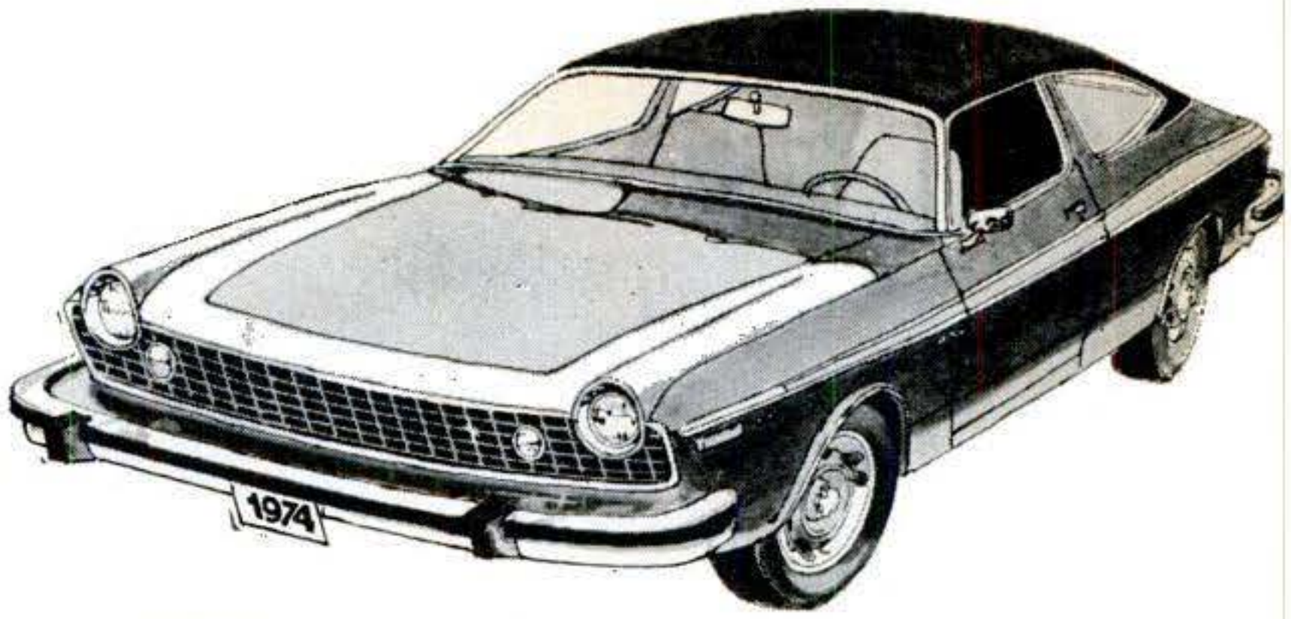
CAPRICE shows minor reworking of the front end. Due to new bumper laws, parking lights are moved up to a safe position where they won't be damaged in a low-speed collision.



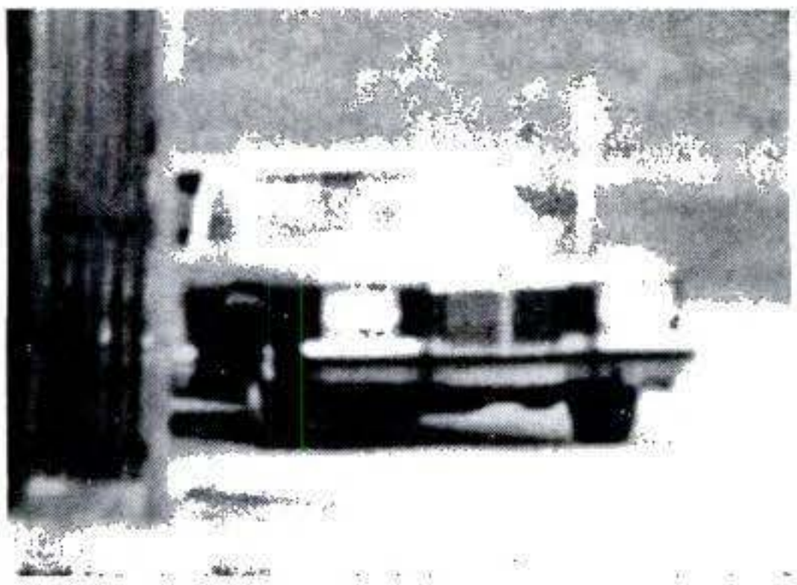
MATADOR from American Motors will have brand-new two-door models (but minor changes on the four-doors). Styling theme follows Hornet Hatchback: lower belt line, more glass.

CONTINENTAL again gets a new grille. Designers have a problem: It must be different from Mercury's but not too much like Mark IV's, yet belong in the same family as both.

CONTINENTAL MARK IV keeps its Rolls-Royce-inspired grille, hiding it behind a new, stronger bumper. A new 502-cu.-in. V8 will be standard on Fo-Mo-Co's flagship car.

Than You Expected

By JIM DUNNE / *PS Detroit Editor*



CATALINA echoes the body changes on all full-size GM two-doors: The hardtop has been replaced by the pillared coupe.

FURY by Plymouth gets a complete sheet metal change. The belt line is two inches lower, and the side glass has less curvature than on the current model. The interior sports a new instrument panel and new door-window cranks.

CADILLAC will drop the hardtop styling from its two-door models and change over to the center-pillar design.

World's Tallest in Toronto—

Needle-shaped 1805-foot TV tower will be record-high freestanding structure

By HERBERT SHULDINER ILLUSTRATIONS BY RAY PIOCH

Inching skyward at the rate of 18 feet a day, a new cloud scraper is reaching for the title of world's tallest freestanding structure.

Begun last month, the new CN Tower in Toronto, Canada, will eventually be 1805 feet tall—towering above the Sears Building in Chicago, the Moscow TV tower, and all other man-made skyscrapers. Of course, there's still the TV transmission tower of KTHI in Fargo, N.D., which is 2063 feet tall—but it's held up by guy cables and is not self-supporting.

The CN Tower, which is being bankrolled by Canadian National Railways, is seemingly pulling itself up by its bootstraps. It's being built with the aid of a rig that has 54 jacks on top. This raises a series of slip forms to allow continuous pouring of concrete. By the time four feet of concrete is poured, the bottom few inches have cured enough to support weight. So the slip forms are raised by that much. The pouring goes on around the clock, five days a week.

Project engineers expect the great concrete shaft will be completed by November. The concrete will top out at 1500 feet. Then a 305-foot television-transmission antenna mast will be added to give the structure its full height.

Walls of the CN tower range from thirty inches to eighteen inches in thickness at the central core. The wings are eighteen inches thick. The building is made of reinforced and prestressed concrete. Reinforcing rods are of varying thicknesses. About 53,000 cubic yards, or 106,000 tons of concrete will be used in the structure. There will also be 5000 tons of reinforcing

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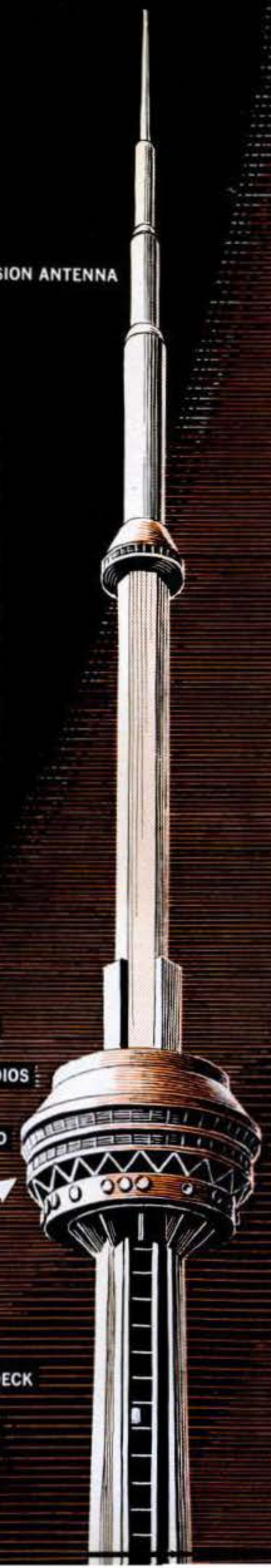

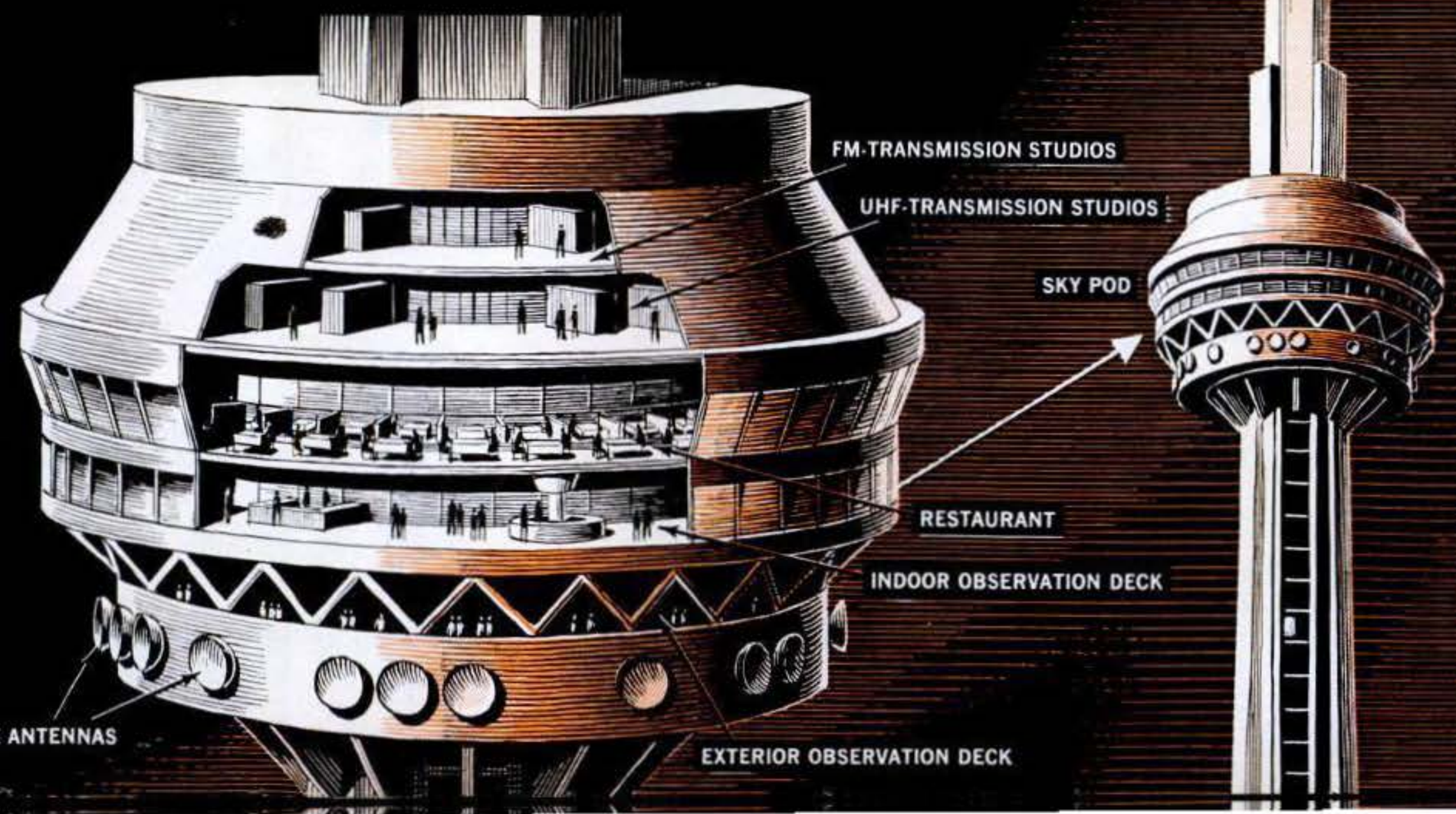

Lofty "Sky Pod" houses observation and restaurant levels, which wrap around Toronto tower beginning at 1100-foot level. Tables in the restaurant will be on a revolving platform, giving diners a 360-degree view of the city below them. Getting up to the Sky Pod will be a breathless experience. Elevators in glass-encased shafts will speed you from street level to the six-story pod in a minute. The elevators will be able to carry 1300 people an hour each way. Tower officials say that visibility will be 75 miles on clear days. In addition to the restaurant, indoor and outdoor observation decks, there will be broadcasting studios, a snack-bar, and display areas in the pod. A total of 70,000 feet of space is available in the six levels of the 80-foot-high pod, which ranges between 100 and 140 feet in diameter. Above the Sky Pod will be a 305-foot transmission antenna that will improve broadcast reception in the area.

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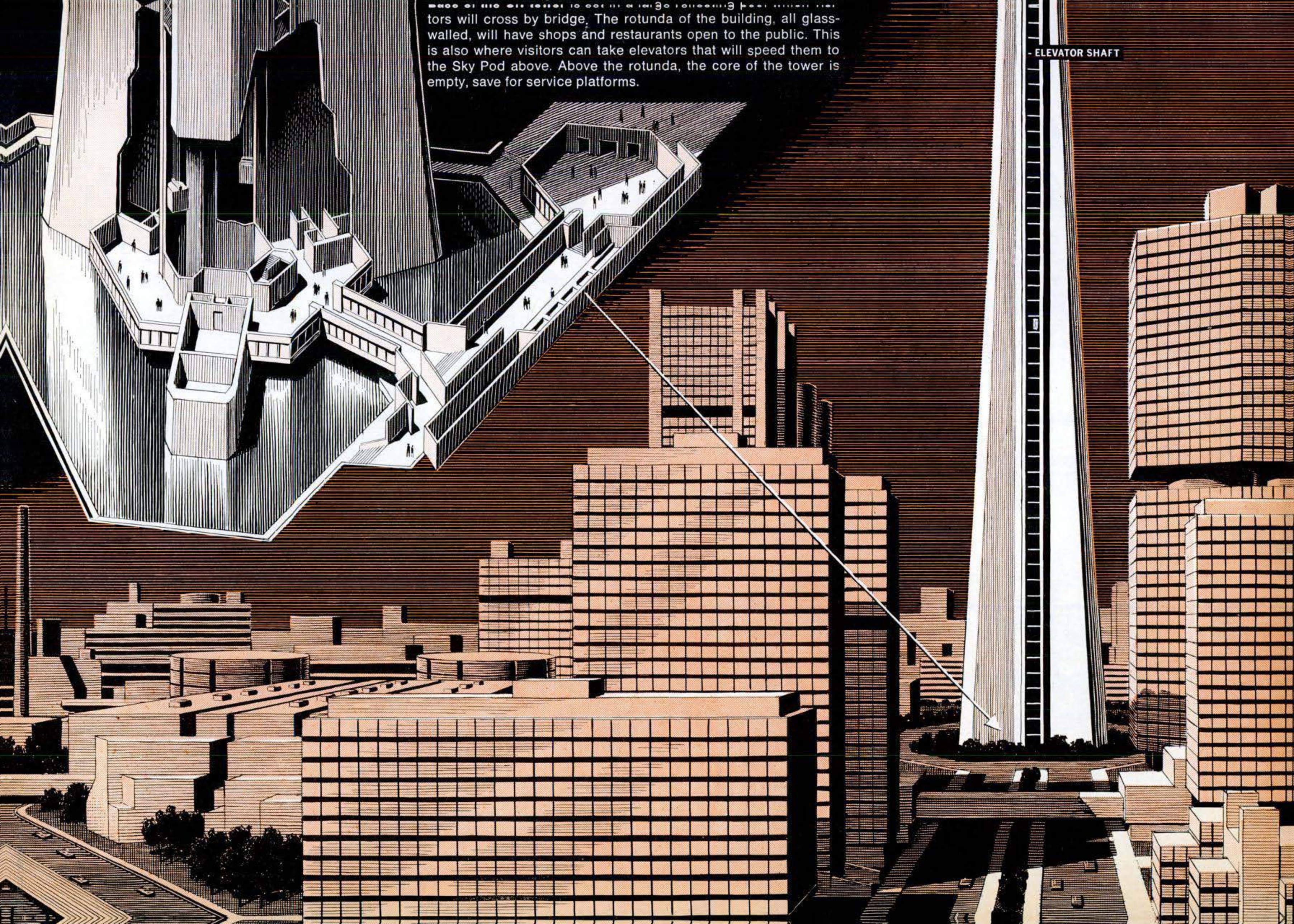
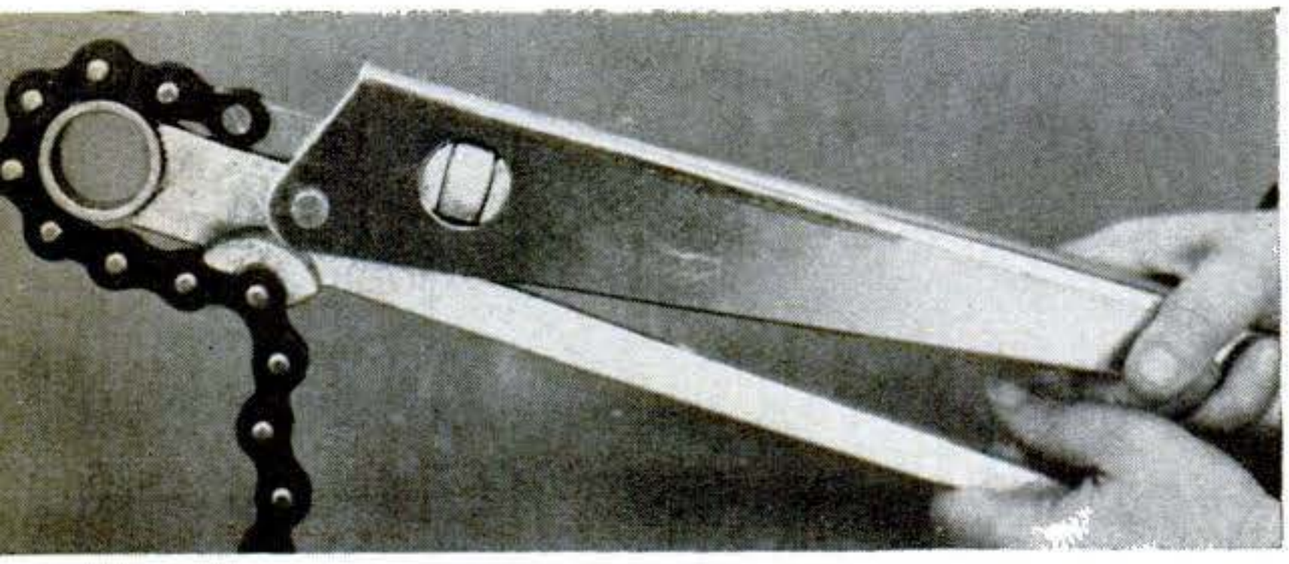


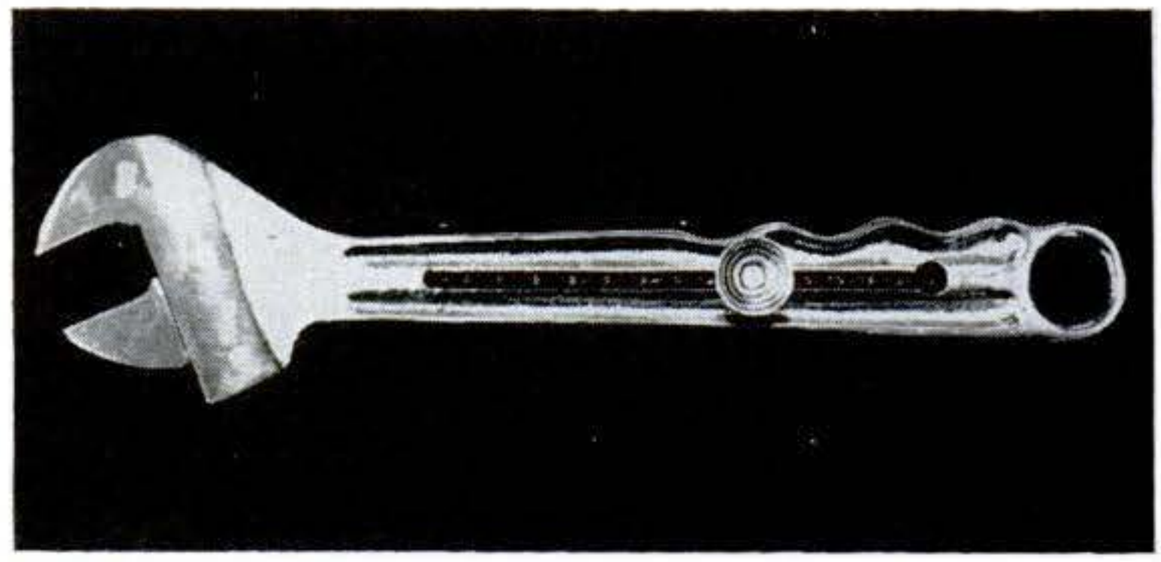
tors will cross by bridge. The rotunda of the building, all glass-walled, will have shops and restaurants open to the public. This is also where visitors can take elevators that will speed them to the Sky Pod above. Above the rotunda, the core of the tower is empty, save for service platforms.

Superplay game lets a player "drive" toy cars and planes over the game's surface area. Steering and speed controls manipulate a moving magnet under the board, which in turn guides models to which magnets are affixed.

Interlingual typewriter has a rotating cylindrical drum that holds as many as 6000 characters. Thus, it can type languages with enormous alphabets, such as Chinese. A coded grid of 160 keys is used to select correct character.



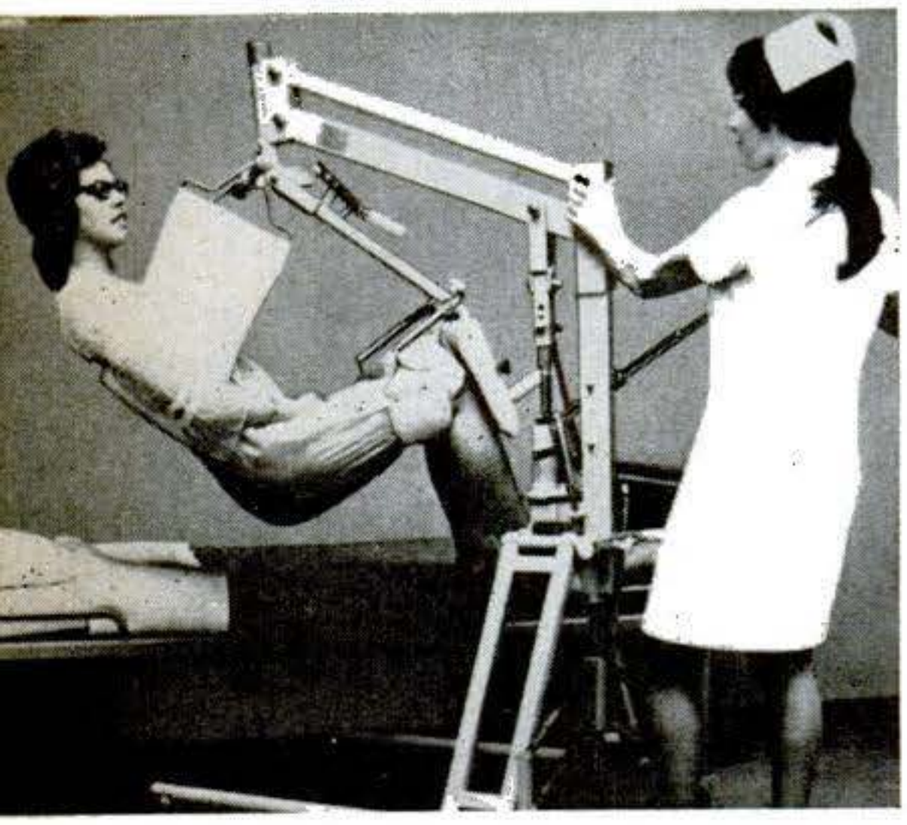
Swiss "Germo" version of a chain wrench for pipe can be manipulated in very narrow spaces and works equally well when used right- or left-handed. V-block grip helps prevent deformation of the piping, and makes turning easier.



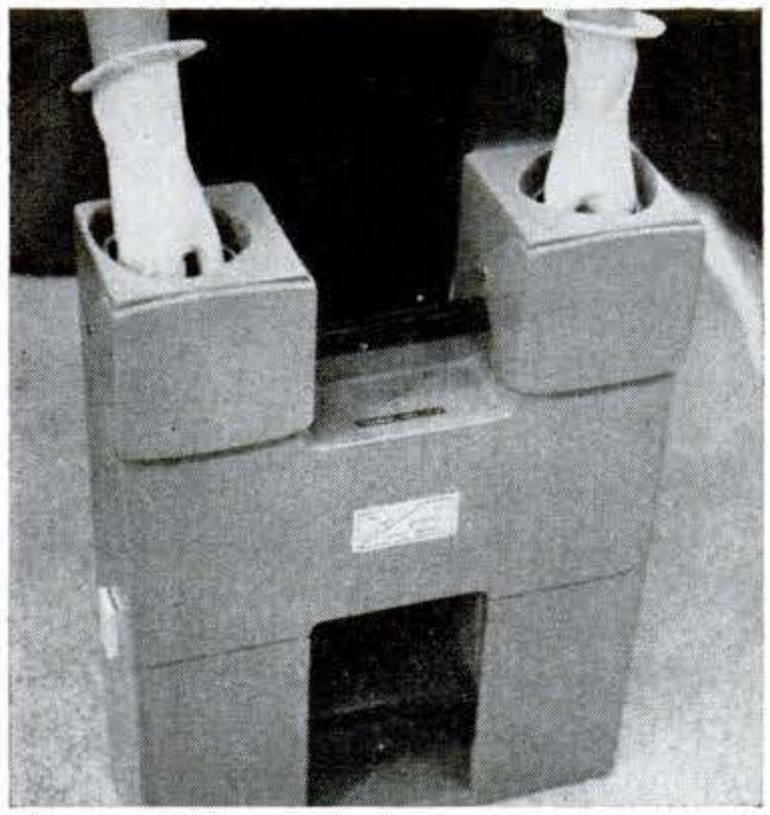
With Miller instant-grip wrench you just slide a thumb tab to close the jaw on the work. Basic design was improved by changing worm gears to meshing conical angles. Special obliquely opposed teeth in the jaws reduce slippage.

13 ingenious inventions from the world over, at PATEXPO '73

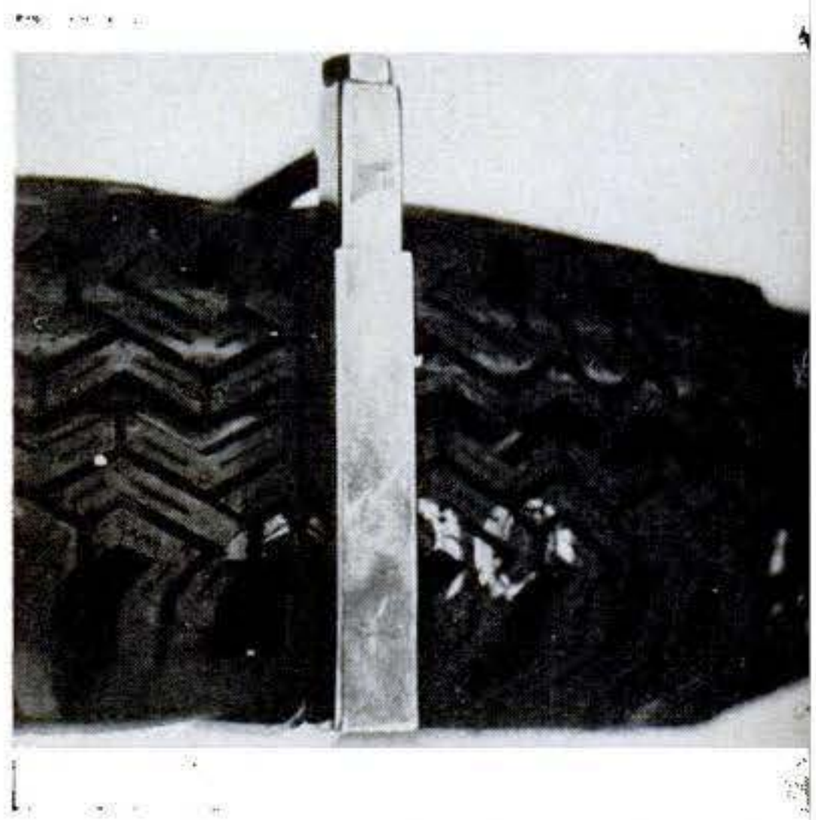
PS Science and Engineering Editor Arthur Fisher picks a baker's dozen of dazzling gadgets from New York's International Patent and Licensing Exposition



"Steel nurse" enables one person to lift an invalid from his bed for treatment, transfer, or bedmaking without strain or risk. Device uses hydraulic system, will swing, pivot, lift, lower at touch of the appropriate lever.



Glover gets gloves on—or off—your hands fast, with no pulling and struggling. You place hands in holes, step on foot treadle, and gloves are on. Operation can also be reversed. Unit serves as glove storage between wearings.



Grabbers provide simple way to get your car unstuck in snow, mud, sand. One clamped on each rear wheel provides traction to get underway. Threaded bolt, tightened with wrench included, locks two halves of Grabber together.

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Probe-Lite throws light into small openings—cartridge cases, for example—without getting in the way of your view. Difference from standard penlight format is position of bulb—perpendicular to axis of battery holder, not parallel.

Astro Shades add comfort by eliminating the feeling of eyeglass pressure on the nose; they suspend the weight of glasses from the frame resting on brow and ears. Fitting is easy with thermoplastic frame. Glasses flip up or down.

Scaffold on wheels gives paint contractor, others, easily maneuverable working scaffold that can be handled by one-man crew. At the push of a button, scaffold will elevate to two-story height, or drop to three feet off the truck bed.

Bag-Ty seals any plastic bag with a twist of the wrist. The aluminum gadget is a double loop connected by a bar. Neck of bag is slid into device while you pull on either loop to seal. Bag is opened by simply pulling Bag-Ty off.

Sun-Grill lightweight solar cooker is shown here boiling a kettle of water. Device focuses sun's rays to produce cooking temperatures in minutes. New wrinkle: For portability, this model collapses like a foldable flash reflector.

Larco Leg-Rest keeps long-distance drivers relaxed and comfortable by providing support to the leg used for accelerator pedal. Fatigue and tension that usually come from keeping your leg in the same spot for hours is alleviated.

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Thirteen little motors, an Avon inflatable, two Grumman canoes, Sears' Jon boat (top), and a Ford Bronco are ready for duty at edge of Everglades where endless backwaters were ideal for testing these small boats and outboard motors.

The Little Outboards: Cheap,

Looking for a motor for your inflatable, dink, canoe, or rowboat? One of these mini-hp jobs may be just what you need

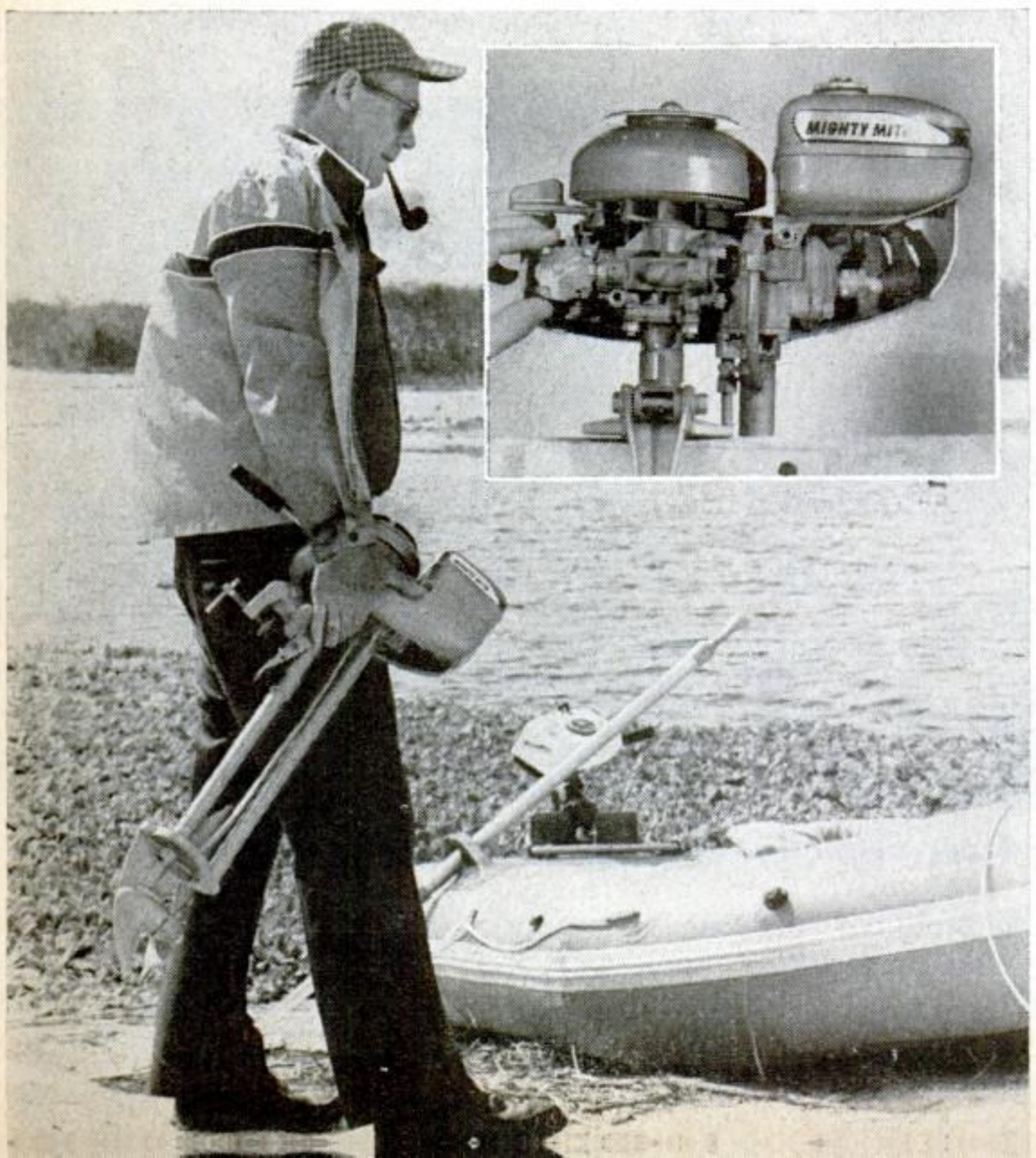
By E. F. LINDSLEY / *PS Midwest Editor*
PHOTOS BY A. J. HAND

If you've been boating more and enjoying it less, it could be time to try a small boat and motor just as a change of pace. For a starter, take a five-hp, or smaller, motor and wander slowly and quietly up one of the thousands of small rivers, streams, and backwaters just waiting to be explored.

We tested 13 little outboards, most of them under five hp (and from $80 to $290) in the Loxahatchee National Wildlife Refuge in Florida. Our little rigs made less noise, splash, and fuss than some of the pelicans. The boats? A 12-foot Sears Jon boat, two Grumman canoes, and an Avon Redcrest inflatable.

If you're used to big motors, get set for some sur-

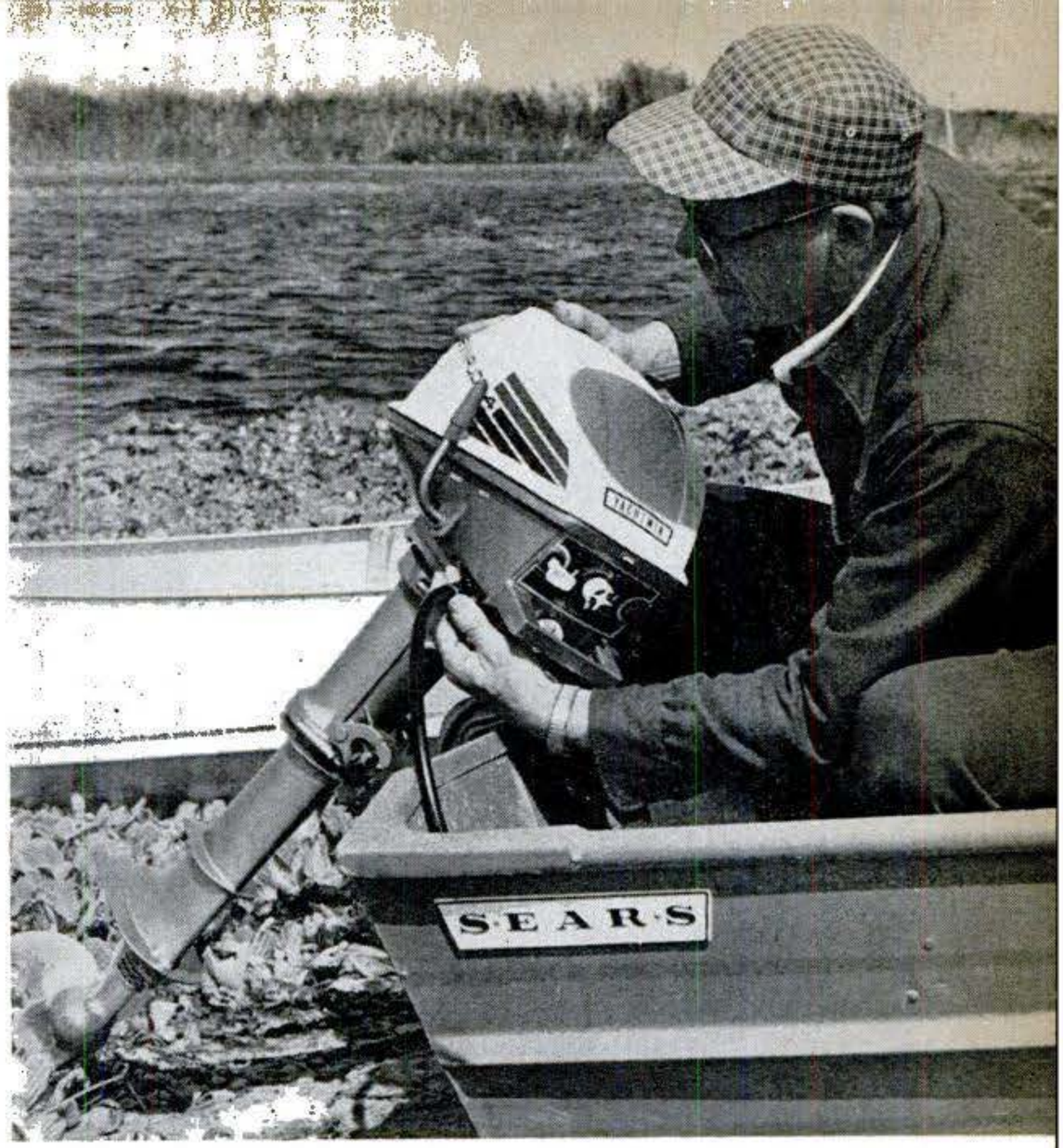
Lightweight Mighty Mite from Neptune is only 17 pounds. Under-two-hp motor is easy to service, has diaphragm carb.



British Seagull has cast-iron block, sturdy castings, and unique spring drive for managing big, slow-speed propeller.

Two-hp Clinton is only $80. Noise and vibration level were higher than other motors, but it still performed faithfully.

3.5-horse Eska proved a good match for the Avon rubber boat, which behaved amazingly well with any outboard.



Quietest and smoothest was twin-cylinder, four-hp Evinrude, but its side-mounted throttle proved difficult to get at.

Portable Power for Small Boats

prises. Small outboards are different. Some we tested, such as the British Seagull and Neptune Mighty Mite, haven't changed much since the 1930s—which shows that they must be doing something right. We found:

- Portable power, most from 8½ to 40 pounds.
- Lots of air-cooled engines.
- Fuel consumption in the cigarette-lighter range. Two gallons goes for hours.
- No frills on some; a full deck on others.

On the theory that small outboards typically will be used by kids, volunteers running the dinghy back to the dock for something you forgot, and Uncle Homer when he sneaks out fishing at daybreak, we violated a cardinal rule and didn't read a single instruction book before starting. This is *not* recommended, but that's the way most motors in this class will be used in real action. Amazingly, all but one started and ran just fine (and that one couldn't have been started if we'd memorized the book, as it had a built-in factory kink).

We even ignored fuel/oil ratio recommendations (to simulate extreme abuse) and used a standard half-pint-per-gallon mix of regular gas and Evinrude TCW oil. Unusual negligence, but some people keep a

Continued

Clutch on Sears 5.5-hp outboard helps when starting and is good safety factor. It was the biggest (hp) we tested.

Luxurious four-hp Merc has twist-grip throttle, gearshift, remote fuel tank, and antishock mounts. Price? A hefty $290.

Cooling fins on Chrysler air-cooled 33-pound 3.6-hp unit are visible here, but good shrouding keeps down noise level.

Two-horse Johnson was good combination with Grumman canoe. Proper ballasting is critical in motorizing canoe.

can of two-stroke mix in the boathouse and this mix gets swapped, borrowed, and used for everything from rotary mowers to chain saws.

What about starting? Admittedly, it sometimes takes a little knack to start a smaller engine the first time. Most start with the prop engaged. Only the four-hp Merc had a gearshift; others you simply pivot around in the mount to back up. Sears', however, has a clutch to let you start and warm up without turning the prop. This is safer, since without gearshift or clutch you're off and running when the engine starts.

Harking back to earlier days, we even felt the effects of the manual spark advance tied into the throttle. The Neptune Mighty Mite actually kicked back. Basic rule: Retard spark and throttle for starting.

Obviously, with the wide cost differences, you might expect some differences in quality. True, but not true. All were pretty well made, but some had fewer parts.

Fancy gas tanks, handsome covers and shrouds, trim die castings, gearshifts, all run up the tab. So do water jackets, water pumps, remote gas tanks, and fuel-transfer systems. Eliminate these and you can still end up with a sound cylinder, piston, and crankshaft that will last for untold running hours.

Eska, for example, a big maker of air-cooled outboards, was reluctant to lend us engines because they felt we'd compare them unfairly with more costly luxury models. Actually, their engines did a fine job for us. As with all the air-cooled models, the noise level was a little higher, but the Eska powerhead is sturdy. These and the other air-cooleds will give you a light and reliable motor.

Testing the outboards. We especially liked the four-hp Merc with its gearshift, water cooling, and twist-grip throttle. This was the most pleasant engine to operate, but its extra weight would lose it votes on a long portage or lug through the woods. The Evinrude four-hp twin, at $270, was another smooth-running gem. We liked its muted quietness.

Small outboards are great for sheltered water and light boats. We don't recommend them, especially for casual users, on open seas with strong winds and waves. The difference between three or four horses and seven or 10 can be vital when the going's rough. Motor trim angle and weight placement in the boat are also proportionately more critical when you lack brute power.

When you've been in the habit of manipulating throttle and shift from a remote forward location, the lever-type throttles on most of the small outboards are awkward at first. There are variations such as the Seagull, with its handy thumb lever on the grip. The side-mounted lever on the Chrysler is not very handy since you have to twist in your seat to reach it.

Full-pivot reverse can also be exciting. You start the engine in forward, since that's the only way to pull the starter, and then quickly spin it to back away from shore.

Other things to remember: Integral tanks usually have vents in the gas cap. These must be opened to run, closed for stowage in a car trunk. Most units had a fuel shut-off valve. Some you unscrew, some you turn, some you tug. Failure to open causes starting problems; failure to close causes leaks. Carburetor drains on many models let you open to check for fuel flow before starting and open to drain the carb after use.

Can they take it? We looked the 13 engines over carefully to evaluate general construction. Conclusions:

- Evinrude, Johnson, Mercury, and Chrysler follow the basic design of their big engines—fine die castings, needle bearings, styling.
- Neptune and British Seagull are novel, using bushings, not needles, are well suited to rough use and on-the-spot repairs.
- Most of the air-cooled models use their basic two-stroke engines, adapted for marine use. Powerhead operating life should differ little.
- Otterbine jet uses a Briggs four-stroke engine to drive a pump instead of a propeller. PS

13 little outboards: how they compare

MAKE & MODEL	HP	CU. IN.	START	SHIFT	SPEED CONTROL	COOLING	FUEL TANK	WT. LBS.	PRICE	COMMENTS
AQUA-BUG 10-S	1	1.3	Recoil	None	Tw. Grp.	Air	Integ.	8½	$120	
BRITISH SEAGULL FP	2-3	—	Rope	None	Grip Lvr.	Water	Integ.	28	195	Rugged, salt-water constr.
CHRYSLER 32-HB	3.6	5.18	Recoil	None	Side Lvr.	Air	Integ.	33	230	Throttle location awkward
CLINTON K-200 K-500	2 5	4.48 6.9	Recoil Recoil	None None	Lever Tw. Grp.	Air Air	Integ. Remote	26 39	79 117	
ESKA 1703-D 1705	3.5 5	5.2 6.00	Recoil Recoil	None None	Lever Lever	Air Air	Integ. Int/Rmt	34 39	92 106	Full needle bearings
JOHNSON 2R73	2	2.64	Recoil	None	Lever	Water	Integ.	24	180	
EVINRUDE 4336	4	5.28	Recoil	None	Lever	Water	Remote	32	270	Twin cylinders
MERC 40	4	5.5	Recoil	F-N-R	Tw. Grp.	Water	Remote	56	290	Very sophisticated engine
NEPTUNE MIGHTY MITE	1.7	2.9	Rope	None	Lever	Water	Integ.	17	109	Simple and rugged
OTTERBINE JET	5	6.9	Recoil	None	Lever	Air	Integ.	27	—	Briggs engine, pump jet.
SEARS 217-59431	5.5	6.0	Recoil	Clutch	Lever	Air	Int/Rmt	40	—	Safer starts w/clutch

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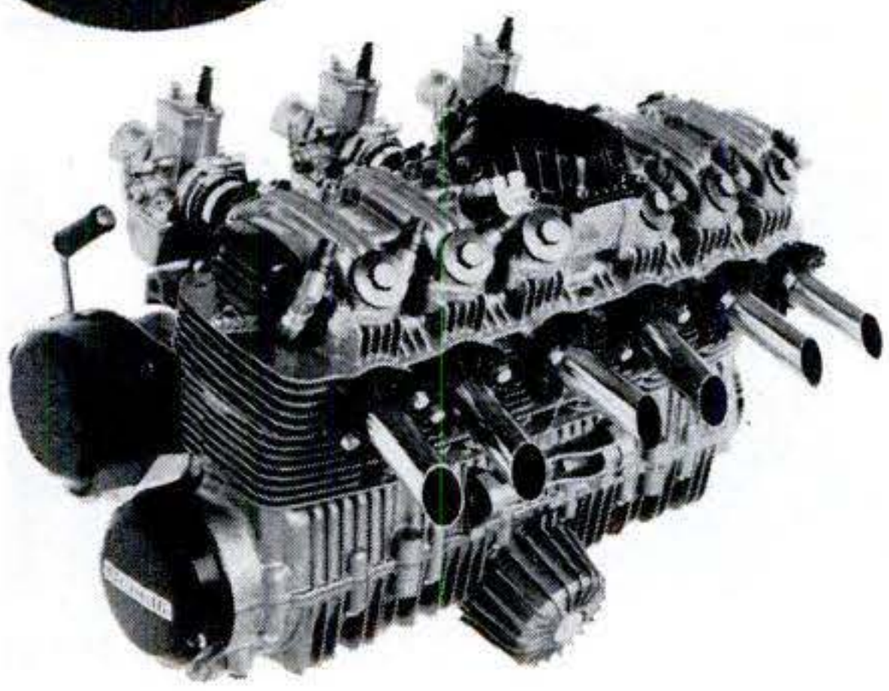
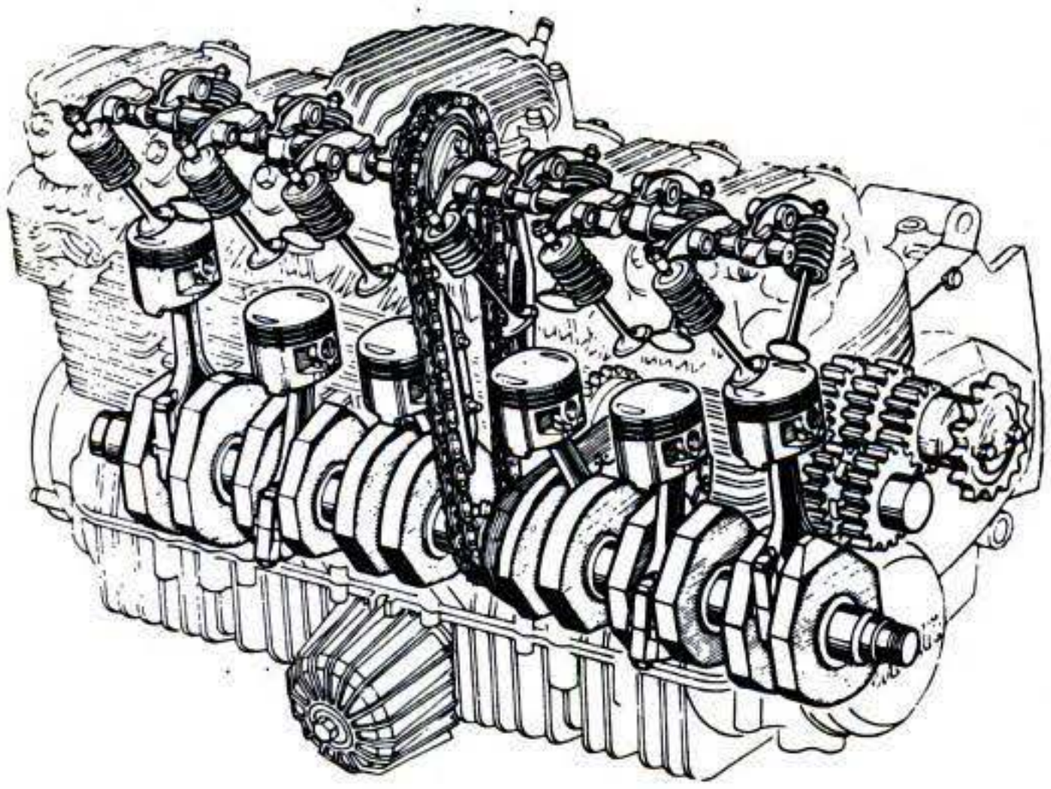
Benelli 750: *first 6-cylinder superbike*

Six upswept mufflers, three stacked on each side, accent the Benelli 750's clean design. Author Ray Hill rates the machine as one of the prettiest superbikes he's seen.



Engine width, surprisingly, is less than two inches greater than Honda's 750cc four. Air space between the cylinders allows effective cooling. Spark plugs are easily accessible.



Single overhead cam is driven by a chain from the one-piece crankshaft. The crankshaft is mounted in seven plain bearings. Bore and stroke are 56 x 50.6-mm, identical to figures for Honda's 500cc four cylinder engine. The biggest difference between the Benelli power-plant and Honda's: those two extra cylinders. Otherwise the Benelli engine design is orthodox by today's standards. Compression ratio is 9:1.

Instruments are easy to read; master cylinder next to the right handgrip is designed to be small and unobtrusive.

BENELLI 750 SPECS

Engine	6-cylinder, 4-stroke, SOHC
Maximum torque	50.63 lb./ft. @6850 rpm
Displacement	747.7cc
Oil capacity	3.17 quarts
Lubrication	Forced, with oil pump
Carburetion	3 Dell'Orto VHB 29
Fuel	High test
Ignition	Distributor with external H.T. coils
Fuel capacity	4.35 gallons
Starting	Electric and kick
Clutch	Wet multidisk
Transmission	5-speed
Gear ratio:	1st: 12.43 2nd: 8.98 3rd: 6.99 4th: 5.74 5th: 4.92
Frame	Double cradle
Wheelbase	55 inches
Price	Not available

For the motorcyclist who has everything, Benelli presents two extra cylinders

By RAY HILL

Japanese motorcycle makers have a strong grip on the superbike market—and Benelli intends to pry it loose. For leverage, the Italian maker is using a spanking-new 750 six. That's right—six 125cc cylinders that crank out a whopping 76 hp at 9000 rpm.

Why six cylinders? Because, say Benelli engineers, bore and stroke in their 750cc engine are smaller than the bore and stroke of competitive 750cc motorcycles with only two, three, or four cylinders. Reduced bore and stroke, plus those extra cylinders, mean faster acceleration, quicker flame propagation, and a smoother-running engine. It also means that you'll have from two to four more cylinders under your gas tank than anybody else.

Three carburetors. The big 45-cubic-inch engine has three carbs, each with a 29mm venturi. Benelli engineers experimented with a six-carb hookup, but chose the three-carb arrangement because it's easier to tune. Each carb feeds gas to two cylinders through a small manifold. They let enough gas in to permit a top speed of more than 125 mph, almost twice as fast as you'll ever want to travel on the highway.

Handling is reported to be first-rate. Part of the reason for this is that the bike's engine sits closer to the ground than the engines in most other superbikes, providing a lower center of gravity. Weight is reasonable — 484 pounds dry. Braking should be excellent. The rear brake is a conventional drum. But the front stopper is a twin-disk setup. And each disk plate is almost 12 inches in diameter and has its own hydraulic cylinder and calipers.

The Benelli 750 is so new that at press time only prototypes existed, and they were on the other side of the Atlantic. So I haven't ridden one yet. When can you ride one? Well, we'll both have to wait a while. Production models won't be shipped to the United States until sometime in 1974. It's a good bet that when they do hit the showroom a lot of people will be waiting. PS

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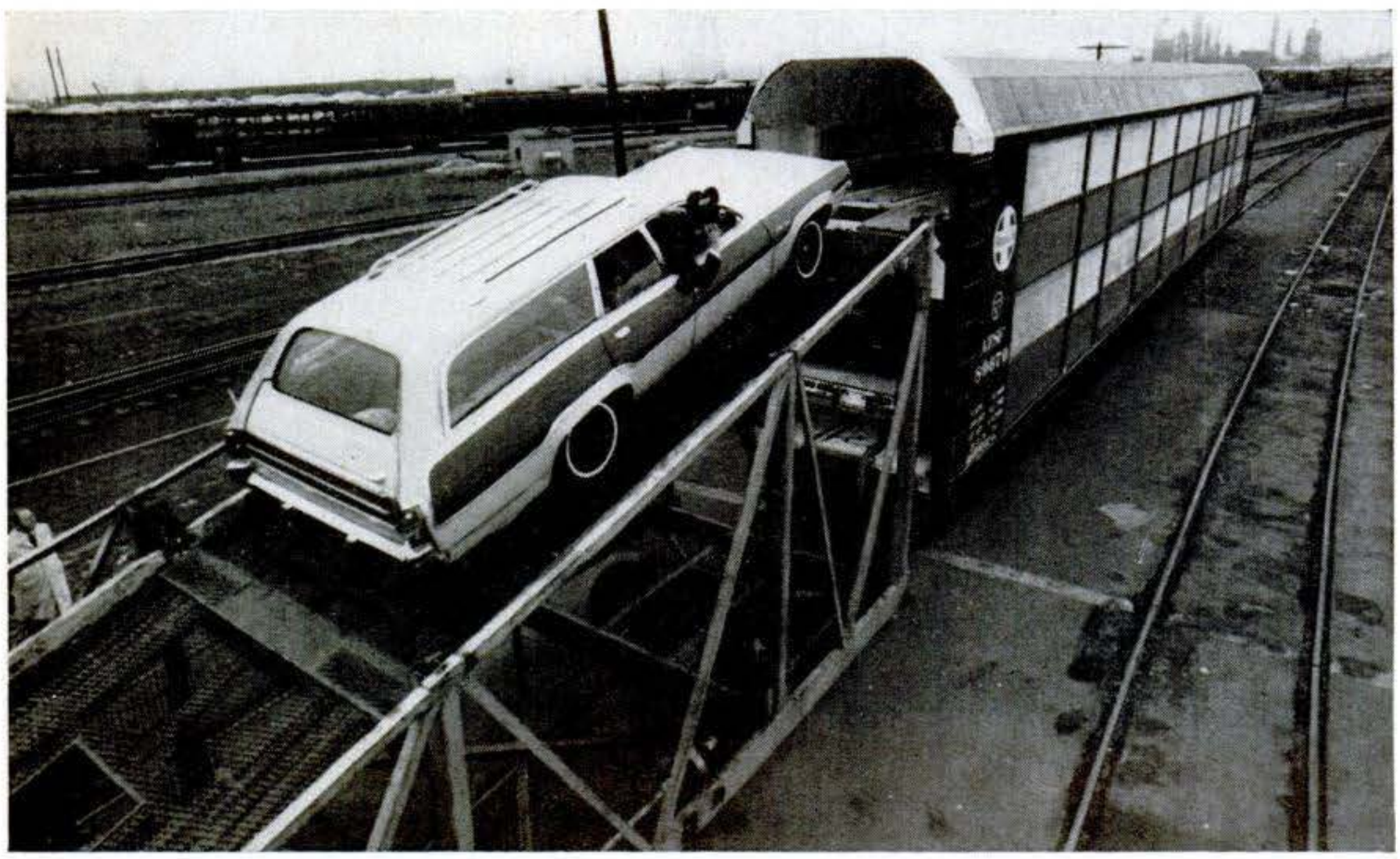
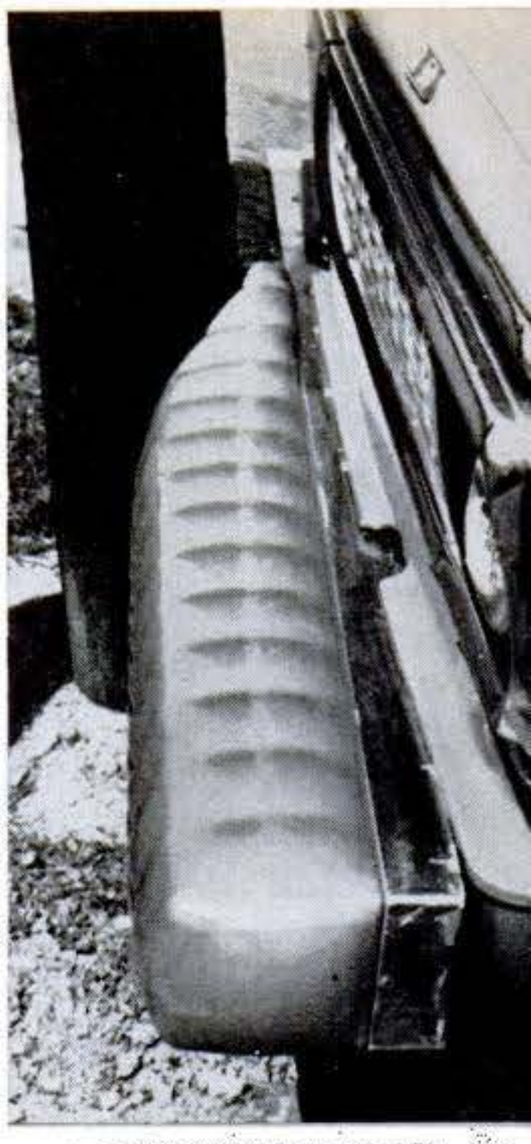
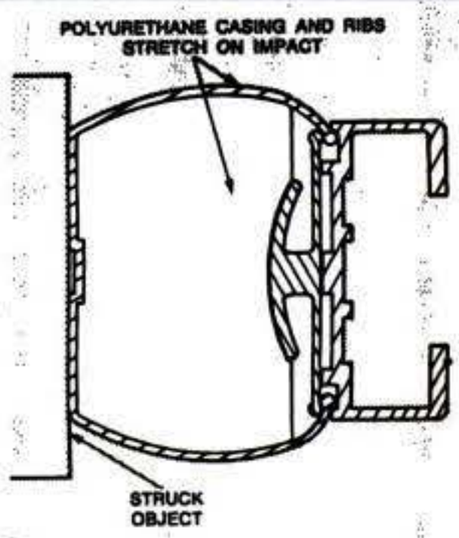
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS





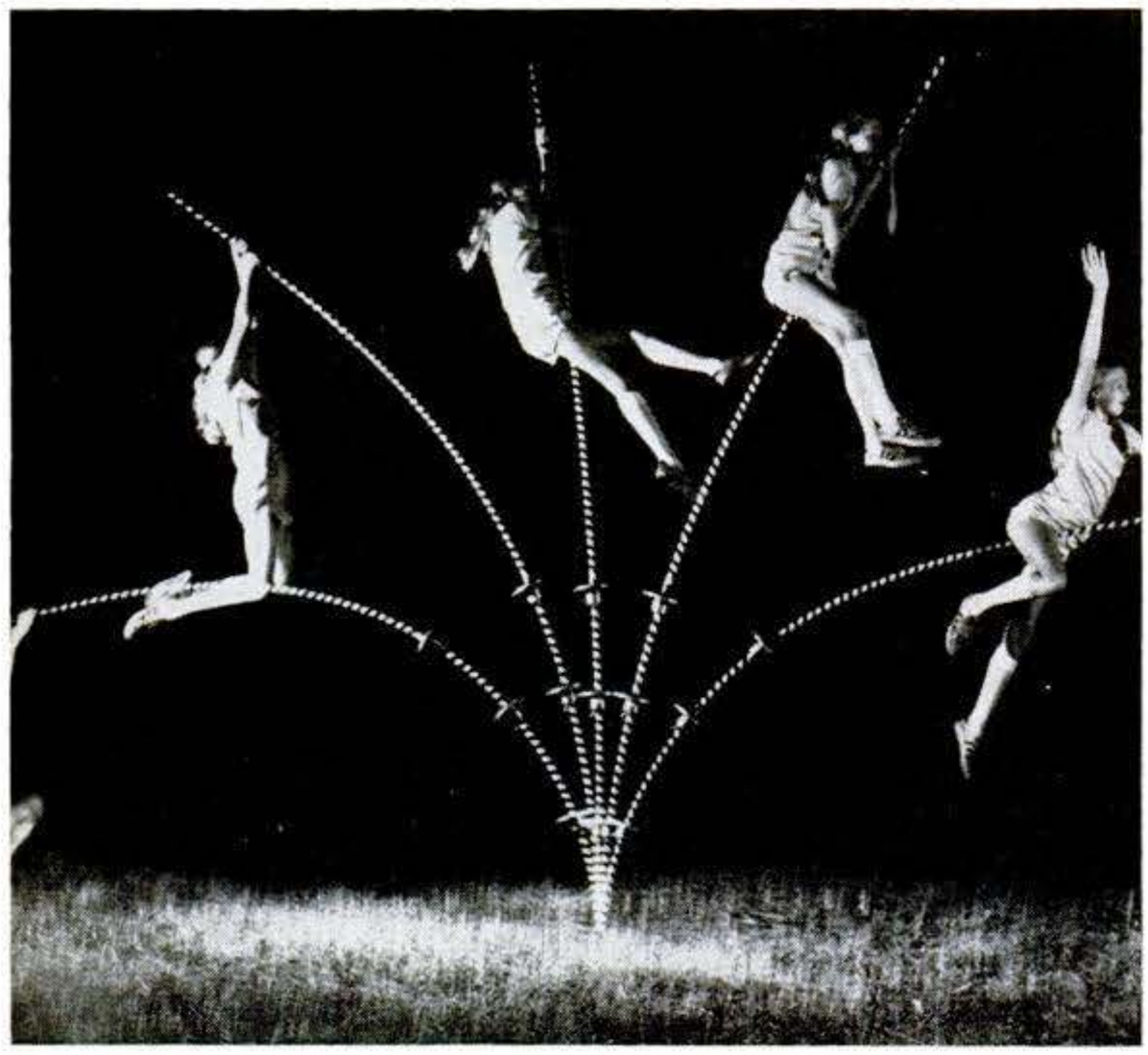


Trilevel car

Three layers of new Chrysler autos can ride from factory to salesrooms in this new trilevel rail car built by Atchison, Topeka & Santa Fe. The rail cars load from the end like a circus train, and are fully enclosed to protect the autos from vandalism and pilferage while en route.

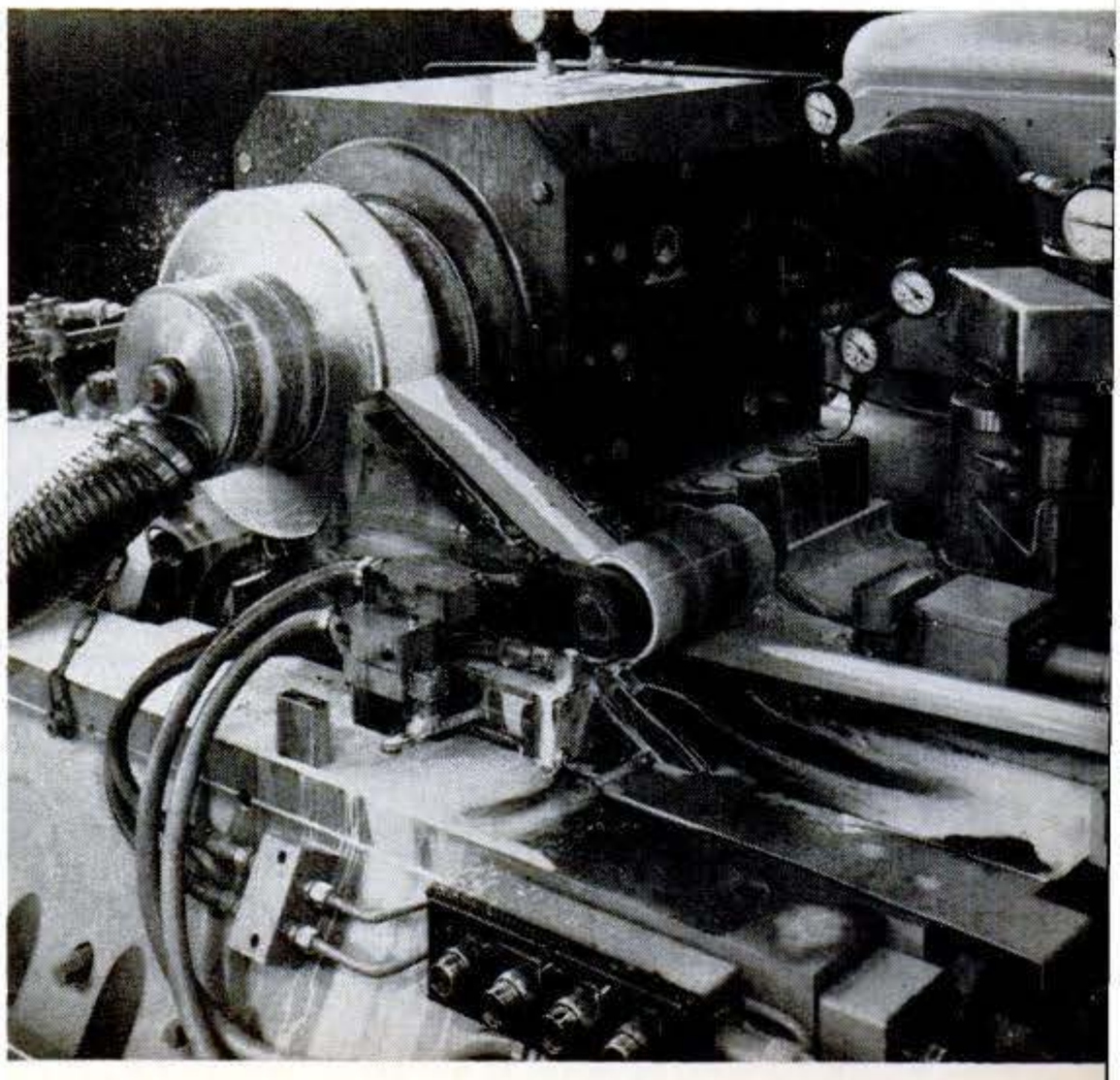
Inflatable bumper

It's built like a tubeless tire—bead locked into grooves of a backup plate. And—inflated—the McCreary bumper works like a tire going over a rock. It deforms, compresses, and changes from a soft cushion to a hard, resistant structure. McCreary Industrial Products says it has kept cars damage-free at crashes over 10 mph.



Action pole

Instead of a springy sapling, look what '73 kids can ride on: a tough, tubular fiberglass pole that offers plenty of action. Flexi-Pole takes an hour to install, says the maker (Flexi-Dyne, Inc., 8770 India Hill Rd., Cincinnati, Ohio 45243), and costs, depending on weight, $175 to $216.



Steel peeler

Peel a stainless-steel billet? This new GM machine does, turning a 180-pound cylinder into a mile of foil, 0.0025 inch thick. One use GM Research Labs sees for the lower-cost foil: in the regenerator of a gas-turbine engine.

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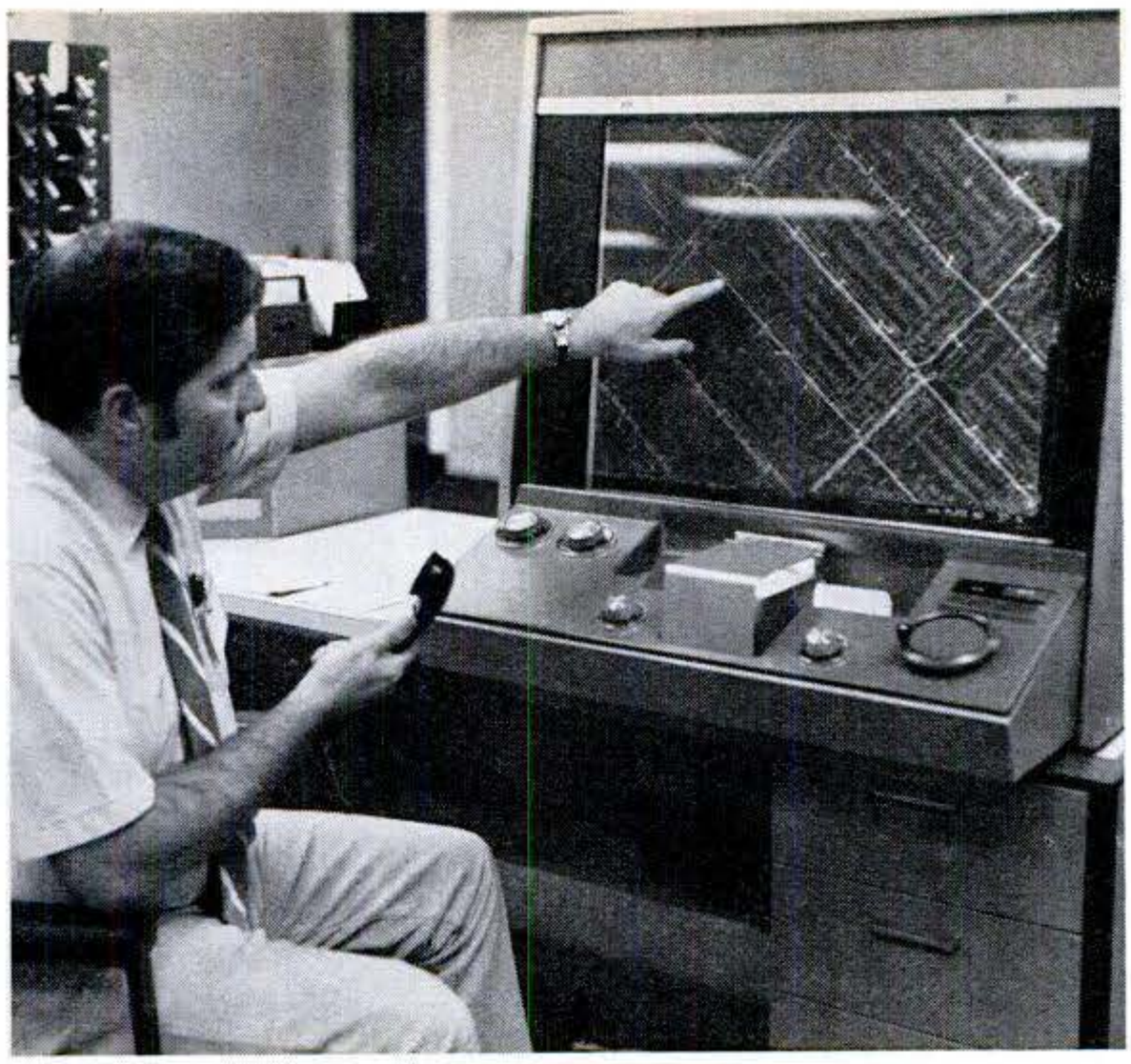
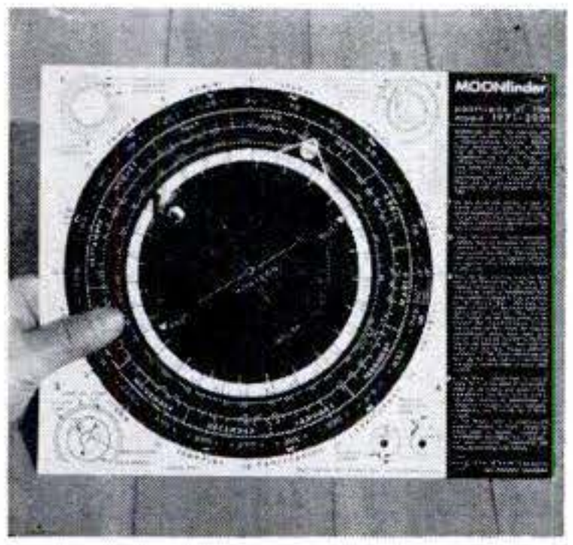


Map reader

When Consolidated Edison servicemen in the field in Brooklyn, N.Y., need to know —quick—where a particular cable is, they get an immediate answer. With 1500 microfilmed maps on file showing all mains, services, and conduits, an emergency foreman can project any map and radio the information.

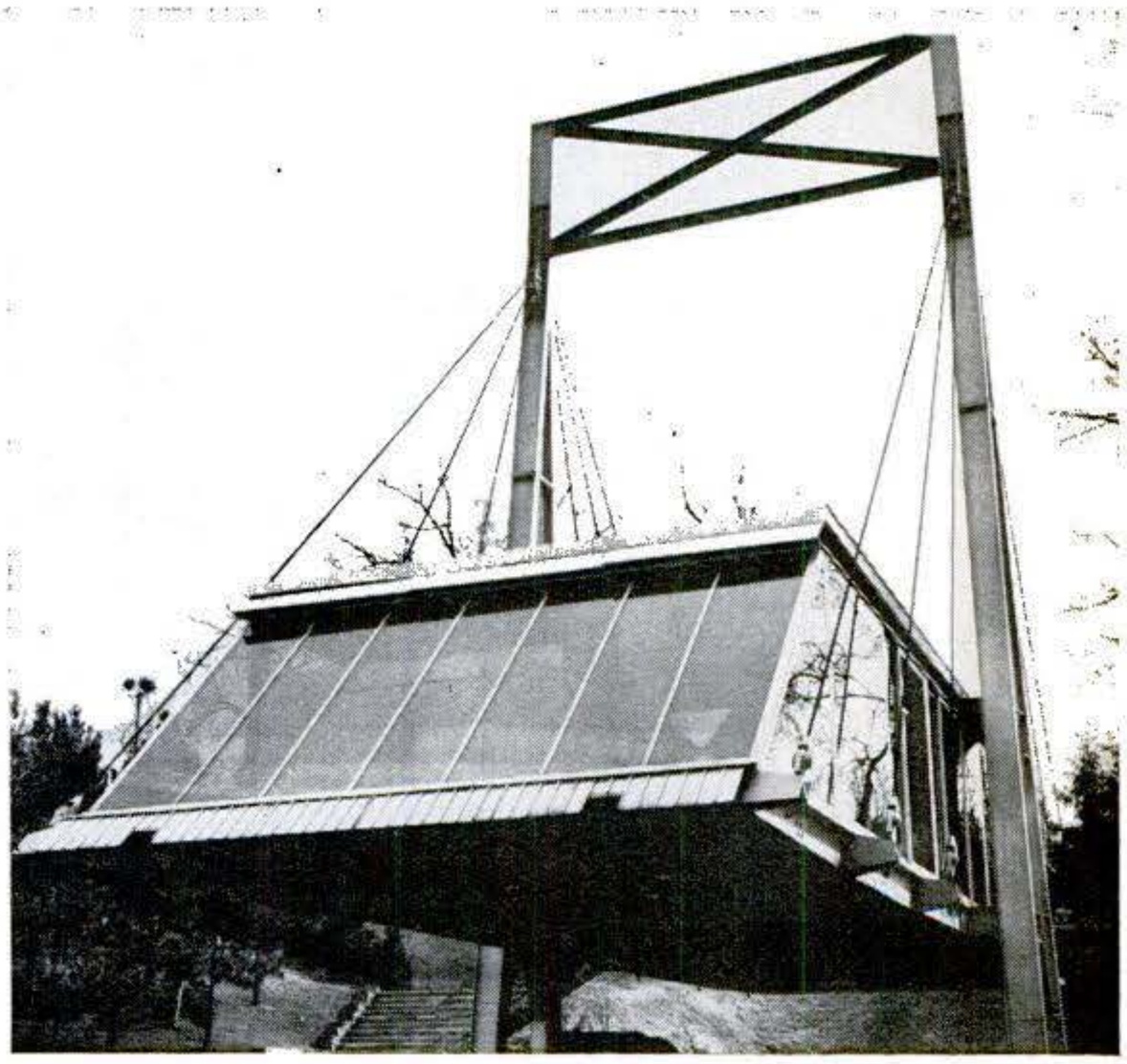
Credit cab

A taxi co-op? They're starting one in Amsterdam, using electric cabs like this one. Members, using coded credit cards, will pick up a cab at one special cab rank, drop it off at another. Batteries will be charged automatically at ranks, through roof contacts.



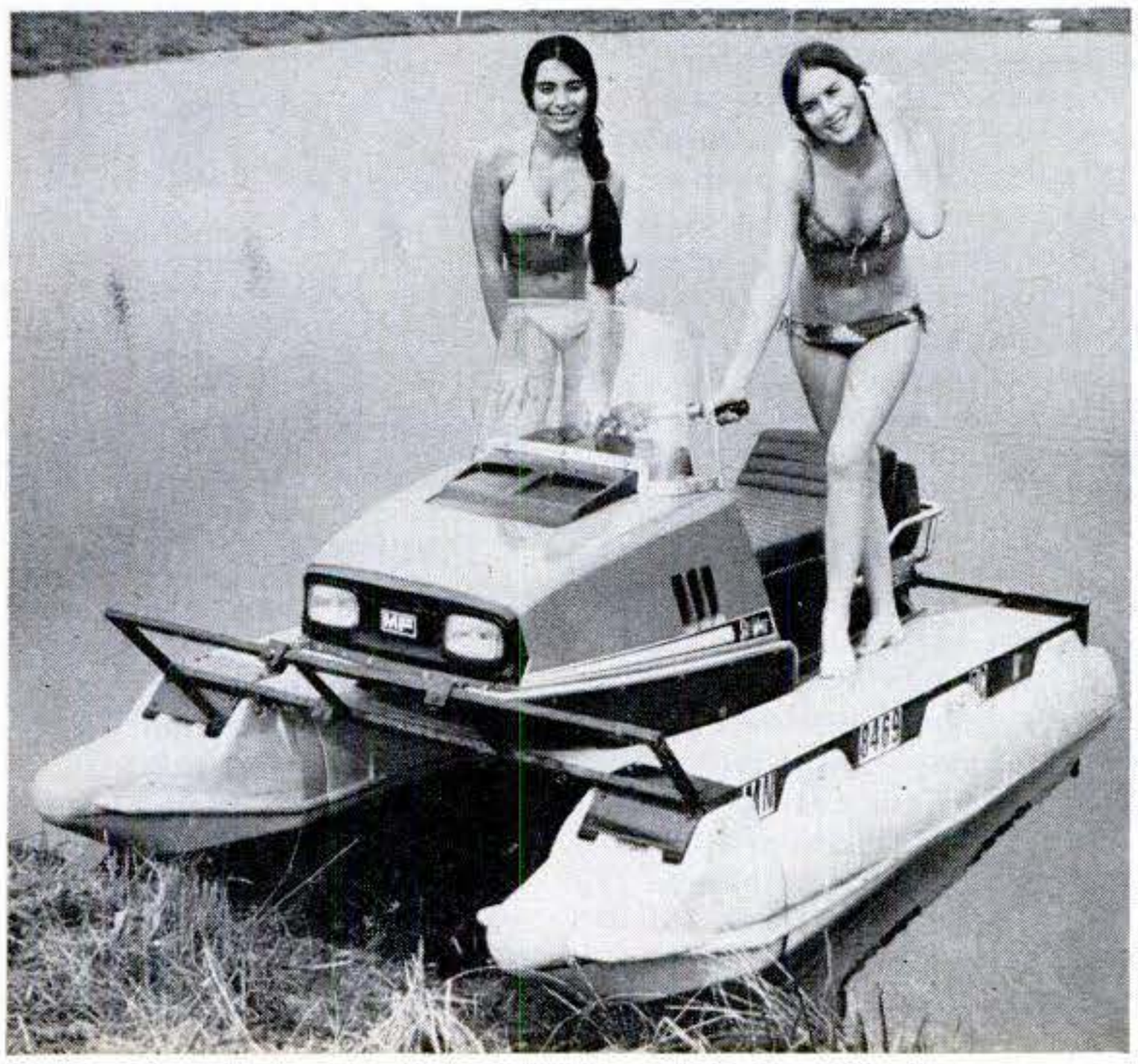
Sky aids

What phase will the moon be in on a particular day? When can it be seen? Spin the dials of the $2.95 Moonfinder, and you'll know in seconds. It's one of four astronomical visual aids made by The Egan Co. (3131-B Divisadero St., San Francisco, Calif. 94123). The others: Planetimer, Startimer ($2.95), and Orbitplan ($1).



Hang-up house

Italian architect Lorenzo Papi calls his creation a tree house. Made of steel, the glass-enclosed house is supported by wire ropes suspended from vertical columns. It's prefabricated for easy assembly and disassembly. No, it doesn't rock.



Snowmoboat

What do you do with a snowmobile when there's no snow? Put floats under it and fill it with girls. That's what Massey-Ferguson engineers did with their Ski-Whiz. The snowmoboat is said to have reached speeds of 25 mph.

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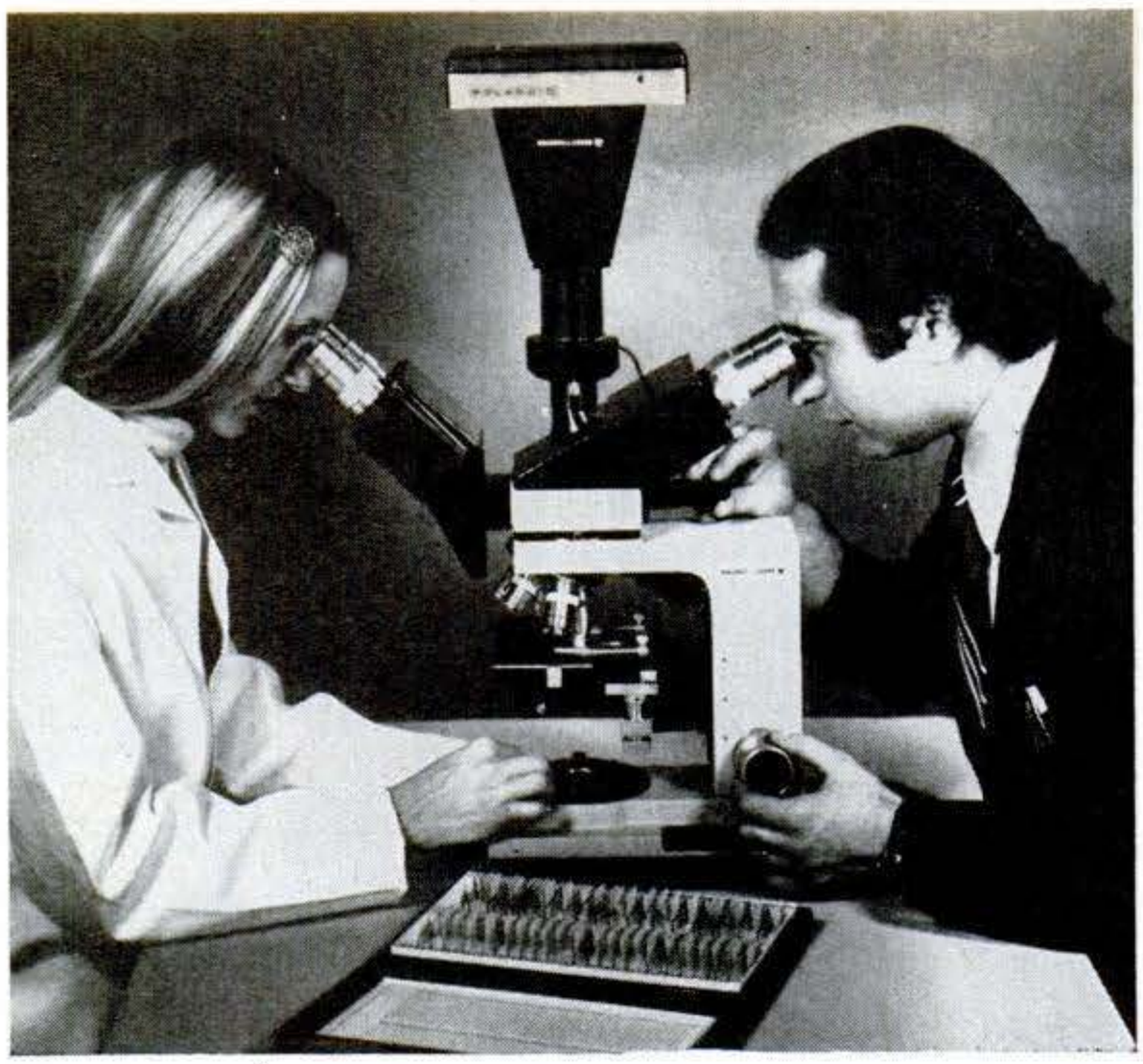
What's New



Dual scope

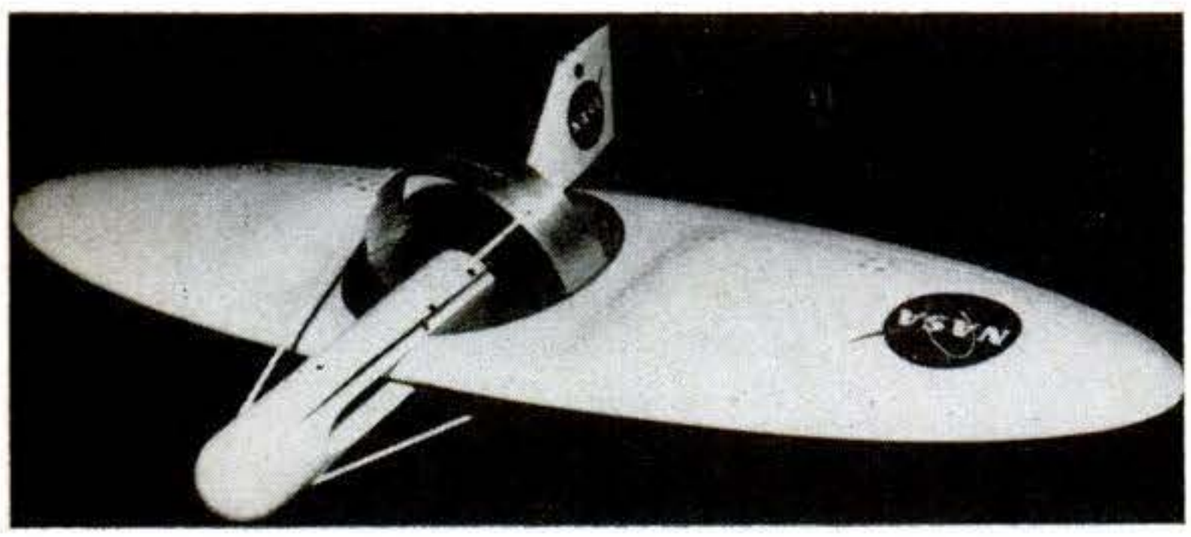
Two can study at once with Bausch and Lomb's new Balplan microscope, while a Polaroid camera stands ready to take a picture. Interchangeable accessories enable users to develop their own systems, with thousands of possible combinations.

Quick fits

Need a new suit? Here's a revolutionary tailor's time-saver. The customer stands against a panel where probes, calipers, and flaps check 30 dimensions. Results go into a computer, and four minutes later the tailor has your measurements. Bellow Machine Co., Ellerby Lane, Leeds LS9 8LE, England.

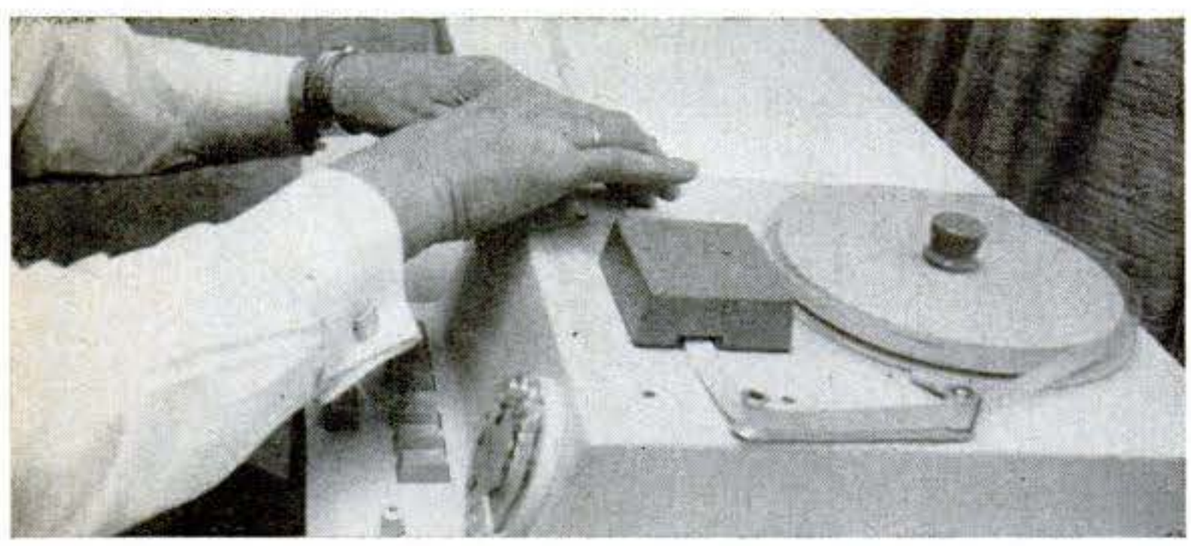
Kit VW

Designed to carry people or freight (up to 2200 pounds) under all sorts of climates, this kit Volkswagen is powered by the air-cooled Beetle engine. It features front-wheel drive and torsion-bar front-wheel suspension. The unit is designed for assembly in developing countries.



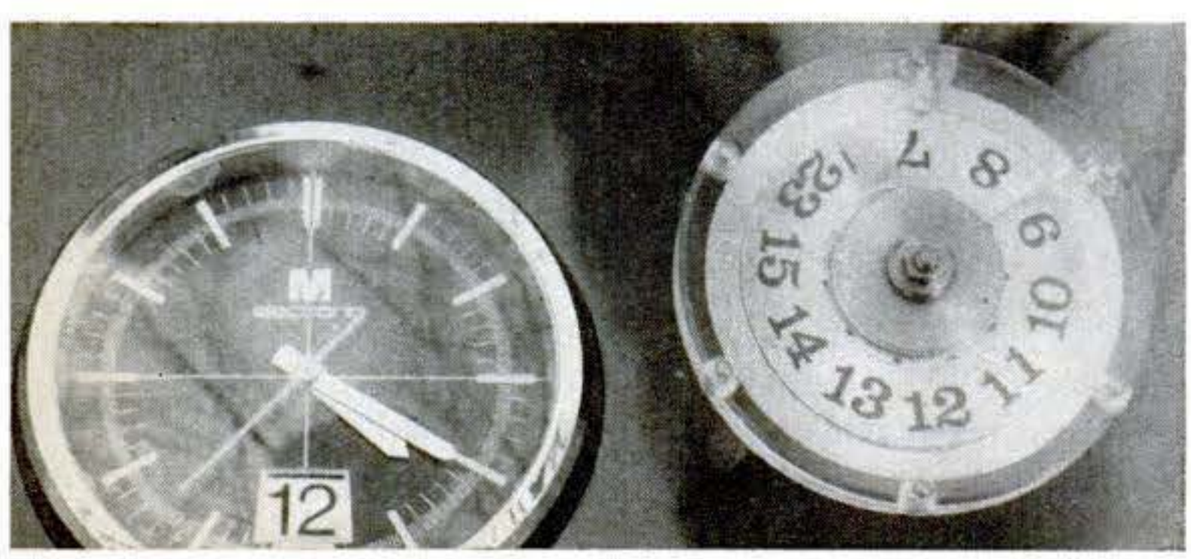
All-wing vehicle

An RPV—Remotely Piloted Vehicle—NASA calls this all-wing wind-tunnel design being tested at Ames Research Center. The wing can be yawed at various angles in flight, and the final craft, powered by a 90-hp engine, will cruise at about 130 knots. First flight? Sometime this fall.



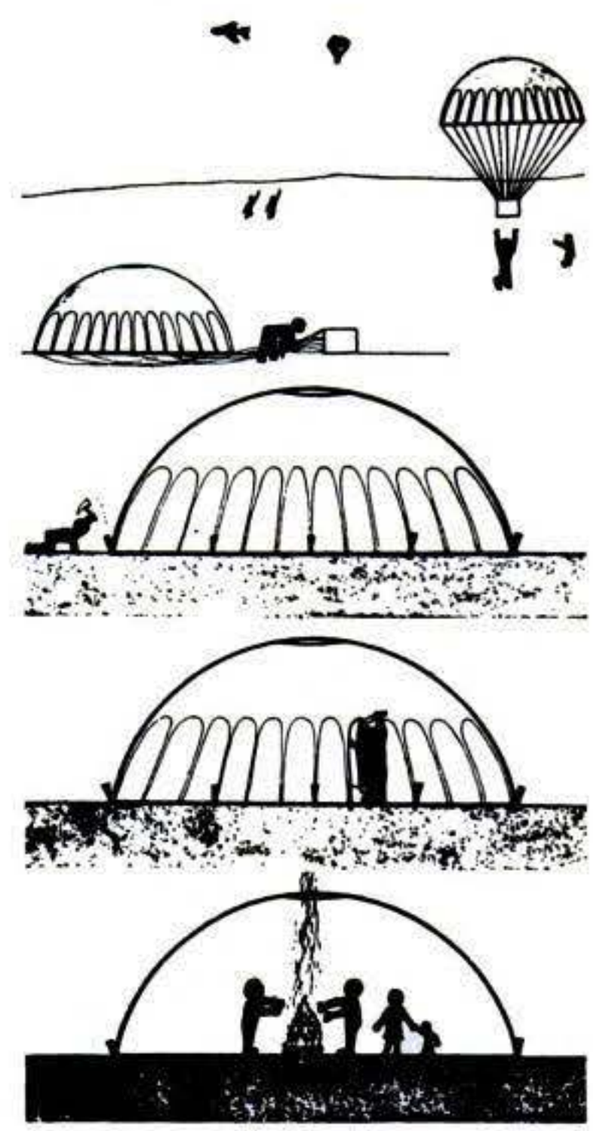
Braillophone

People who can't hear or see can still communicate with each other with German Braillophones. A pocket vibrating receiver lets a party know there's a call, a message is typed on a Braille keyboard, and the receiving party reads the message on a tape with Braille characters. Calls may soon be possible via networks.



Multi-disk days

Dates on calendar clocks and watches can be big and readable with this Swiss multi-disk system, which licks the snag of single disks with tiny numbers. Four overlapping 290-degree disk-segments driven by a slipping clutch complete the 31-day month.



Parachute shelter

As it floats to earth, the descending parachute above is designed to harden, for use as a temporary shelter. Upon landing, it forms a 200-square-foot shelter for a family of five. The secret: a plastic resin that quickly "rigidizes" the chute. It was designed by B.S. Benjamin, University of Kansas.

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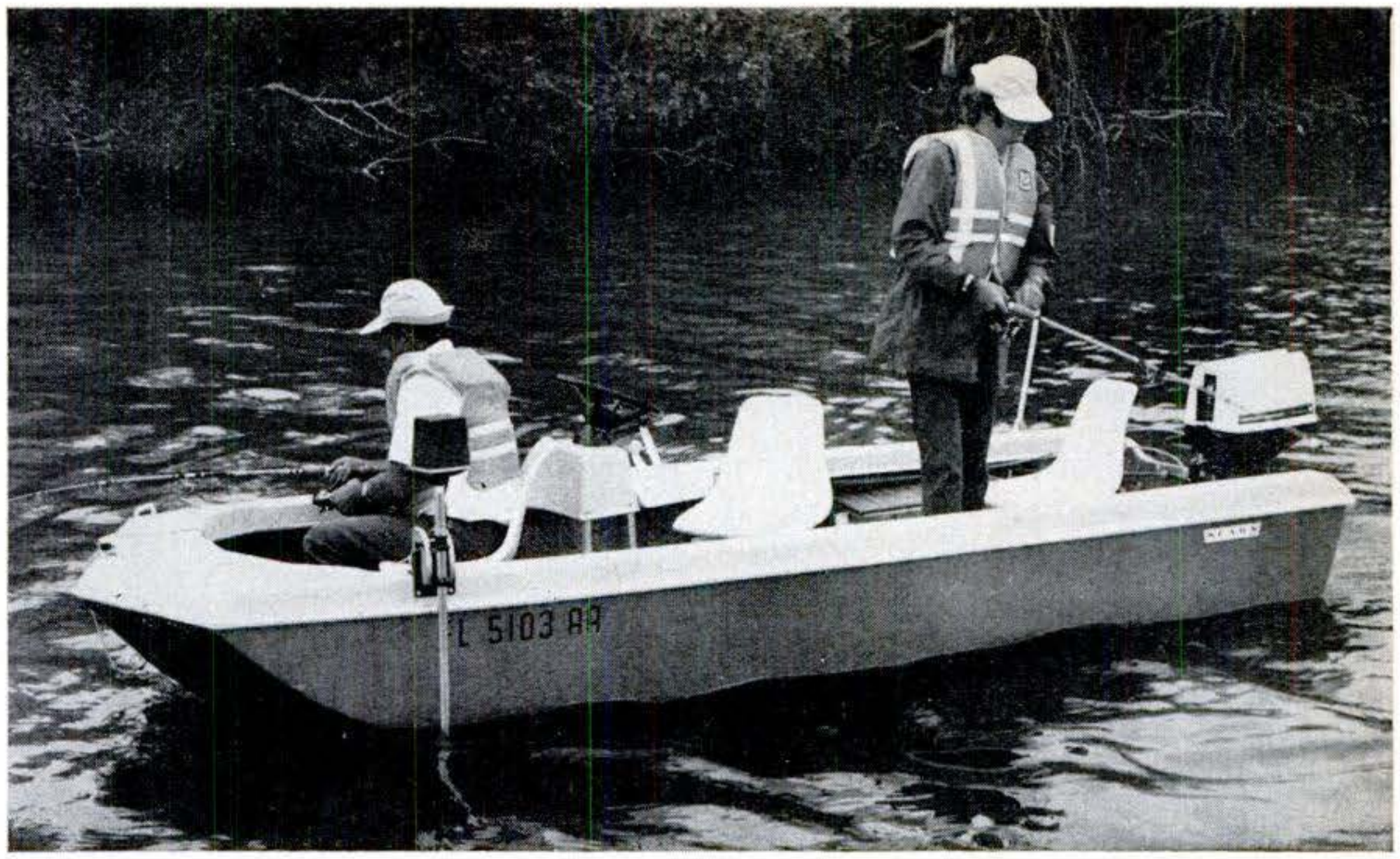
What's New
IN BOATING



Bass boat

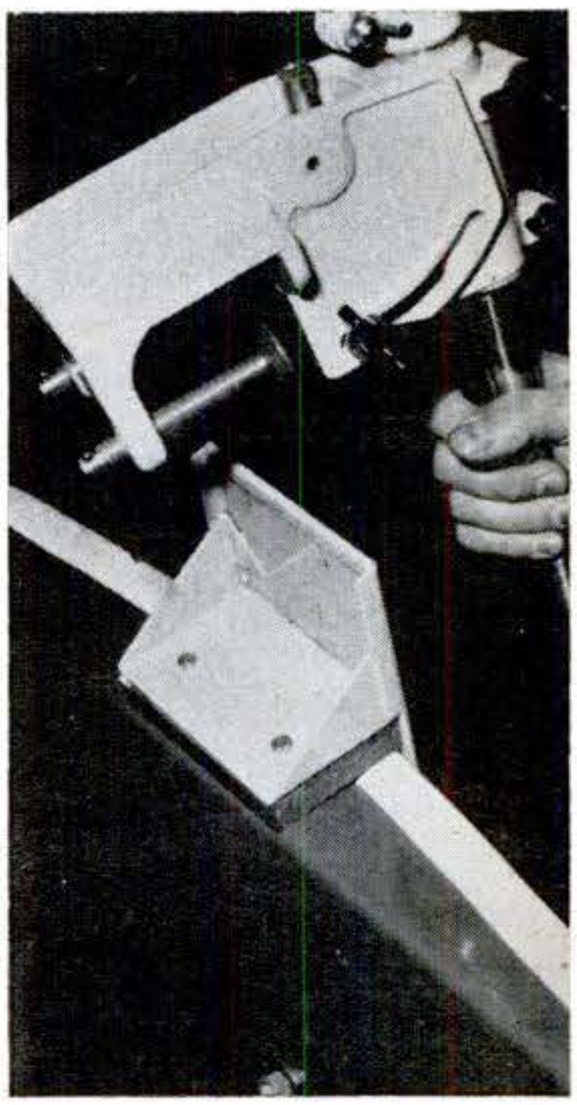
Designed for fishermen, the Deluxe Gamefisher has two swivel seats for fighting the big ones. The 13½-footer weighs 410 pounds, carries 865 pounds, and takes a 25-hp motor. Options? Stick steering, extra seat, and boat cover. You can mount a trolling motor on the gunwale, too. Price? $599 from Sears.

Flexible head

Here's a toilet that can be installed in a tough spot on your boat. Flexi-Mount marine head has a flexible holding tank that'll fit next to coamings, over beams, under seats. Its eight-gallon capacity is good for 50-60 flushes before pumping out. At OMC dealers.

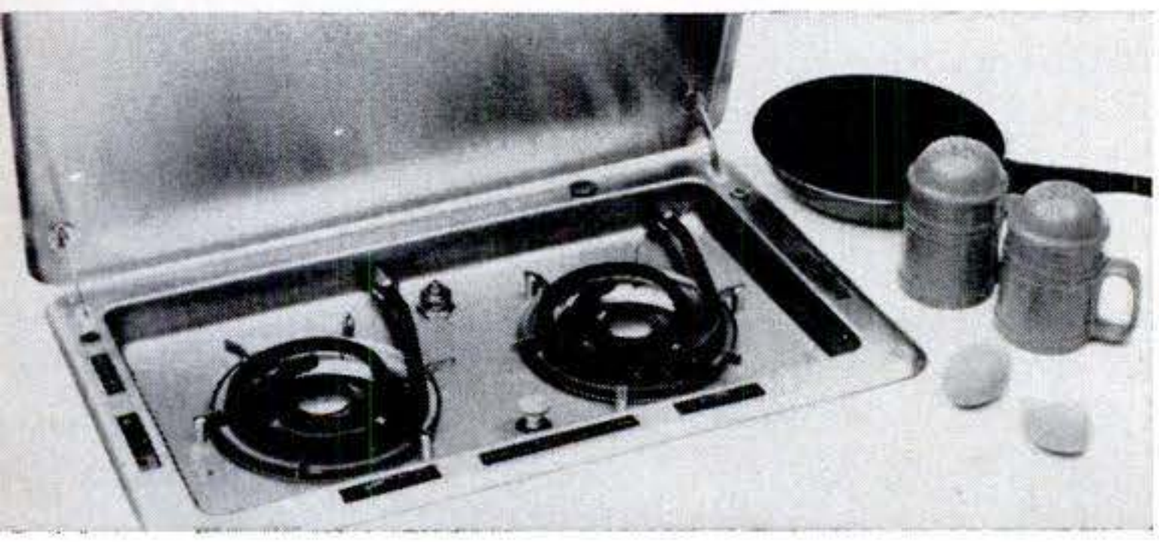
Vinyl fuel tank

"It's one of a kind," says the designer of this new seamless nylon gas tank. The 6¾-gallon tank is saltwaterproof. And it won't rust, dent, or corrode like metal tanks. It comes with twin handles so two can tote it. Maker: Rupco, 4722 Spring Rd., Cleveland, Ohio 44131.



Two-way stove

Alcohol under way or juice from a 110-volt outlet at dockside—this combination two-burner stove lets you cook with either. Both electric and alcohol elements on the Homestrand model 406 swing out for easy cleaning. It weighs 25 pounds, sells for $199.50. Kenyon Marine, New Whitfield St., Guilford, Conn. 06437.



Plastic canoe

Manufactured by a new high-speed plastic-molding process, the Poly-Canoe is shaped into one single piece of polyethylene. The 13-footer weighs only 60 pounds and is cartoppable. Price: $119. Maker: County Plastics Corp., 100 Verdi St., Farmingdale, N.Y. 11735.

Motor bracket

Finally, a universal mounting bracket allows a fisherman to clamp most major trolling motors nearly anywhere on his boat. It's made of heavy-gauge steel with a PVC coating to protect the hull finish. Price: $6.95. Maker: Tempo Products Co., 6200 Cochran Rd., Cleveland, O. 44139.

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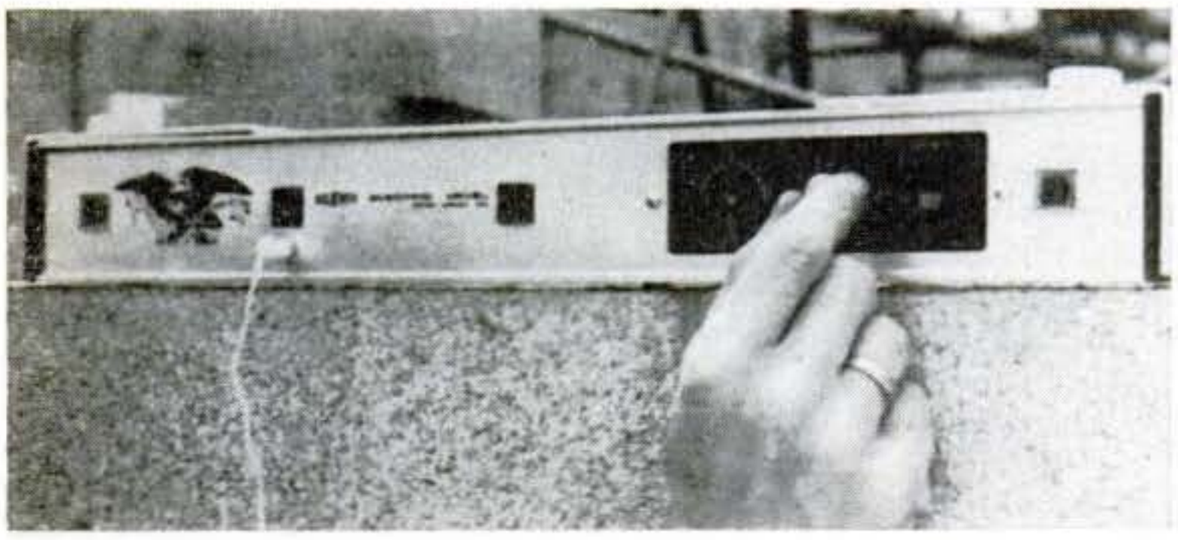
What's New
IN TOOLS

Shop shield

Any time you wear goggles for safety, you'll be safer with a full-face shield. This one is made with a padded headband marked for adjustment to any hat size. The shield fits over eyeglasses; and the plastic is replaceable. Price: $4.95, extra visors $1. Merit Abrasives, 201 W. Manville, Compton, Calif. 90224

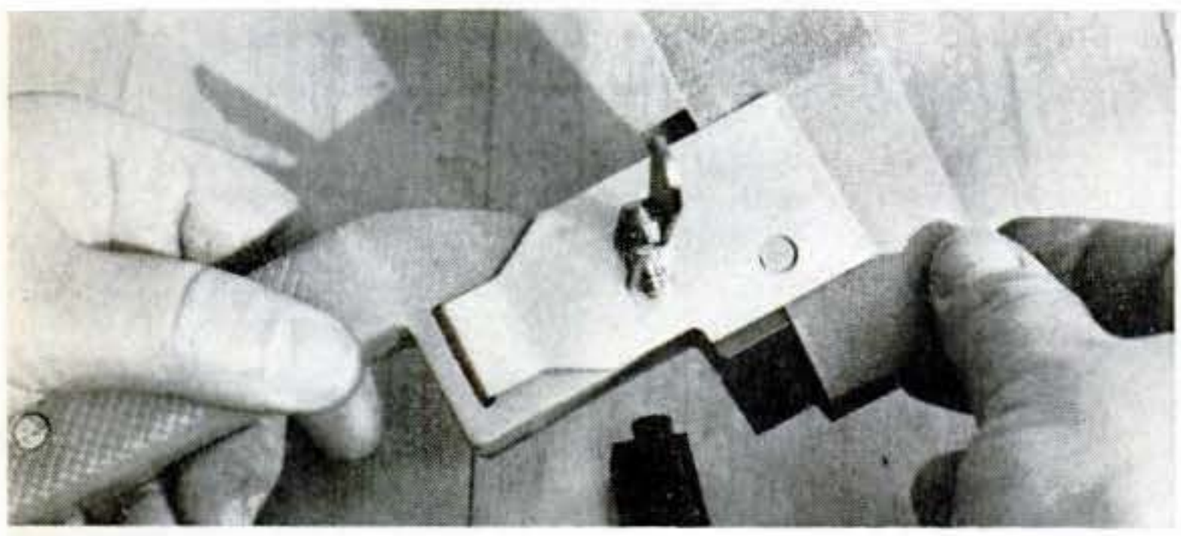
Compact hack

Here's a hacksaw made for work in cramped quarters. It's only 10 in. long (uses 6-in. blades), and its frame tapers toward the nose. You can set the blade in any of six locking positions. The Mel saw is $3.75 (two for $7) from Lorac, Box 882, Inglewood, Calif. 90307.



Level best

An electronic level? You better believe it. It works like this: Set protractor dial to desired angle, and turn it on. A red light and a buzz mean you're on the money. If not, amber lights indicate which end is high. Silveco, 11661 San Vincente Blvd., Suite 1002, Los Angeles, Calif. 90094, makes it. Price? $60.

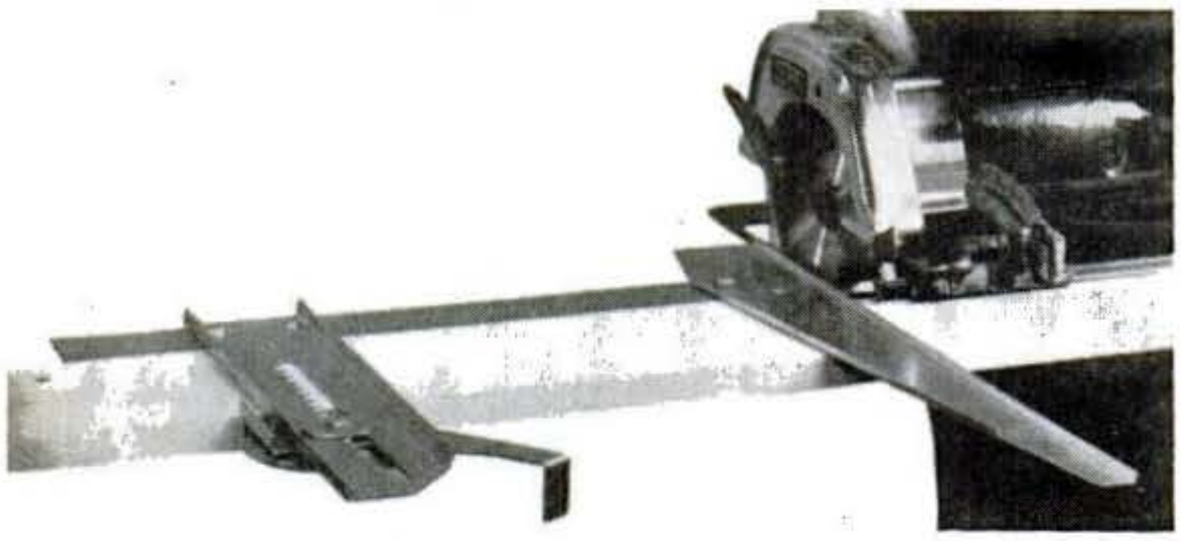


Hand sander

Corners, grooves, molding contours—they're all grist for this sander's mill. Sandpaper strips lock over flat or wedge-shaped inserts. As strips wear, you slide new paper into position. Jim's Dandy Sander is $3.49 from JRJ Ent., 8849 Jamacha Rd., Spring Valley, Calif. 92077.

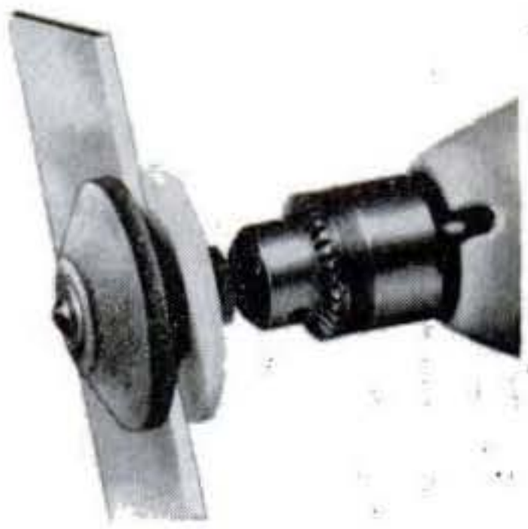
Defuser

When is an aerosol can not a can? When it finds its way into a rubbish fire. Then it's a bomb. Aero-Dispoz ends this safety hazard by letting you depressurize empties before you discard them. It handles all can sizes, sells for $2.49 from K.C. Industries, Box 571, Ogallala, Nebr. 69153.



Cutoff guide

Straight cuts with your cutoff saw are straighter with the Chapco saw guide. A built-in clamp secures it to boards up to 10 in. wide. The guide arm swings 45 degrees left or right for miter cuts, locks at 90 degrees for crosscuts. Chapco, Inc., Chester, Conn. 06412, makes it. Price: $12.95



Hot melt

Here's a hot-melt glue that needs no gun. You light it with a match, dribble the melting glue onto the work, press parts together for a minute, then relax. In 20 minutes, the glue is cured. Five 8-in. Quick Sticks are $1.25 from Don-El Ent., Box 3251, Boulder, Colo. 80303.

Blade grinder

No need to remove your mower blade for sharpening—this sharpener chucks into your ¼-in. drill to do the job in place. Two-sided abrasive wheel reverses for double life, sharpens garden tools, too. It's $1.98 from Arco Tools, 421 W. 203 St., New York, N.Y. 10034.

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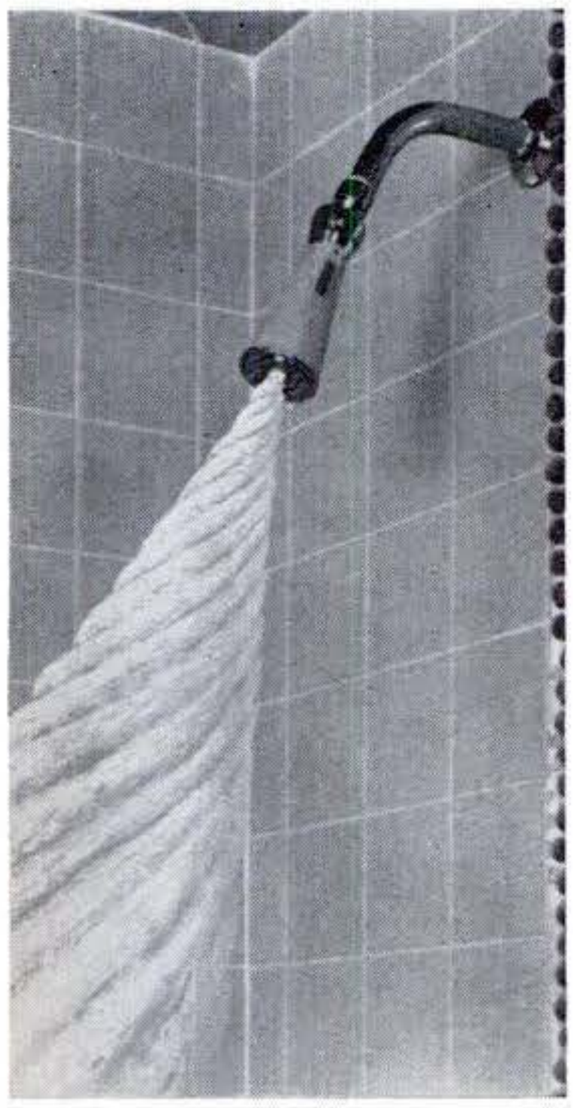
What's New IN HOME IMPROVEMENT

Flexible fit

Got a funny-shaped window? Hotpoint has an air conditioner to fit it. The new Heritage Slider/Casement series is designed to fit narrow casement windows like this one, plus sliding windows and those ultra-narrow double-hung types common in older homes. The series has 6000-, 8000-, and 10,000-Btu models.

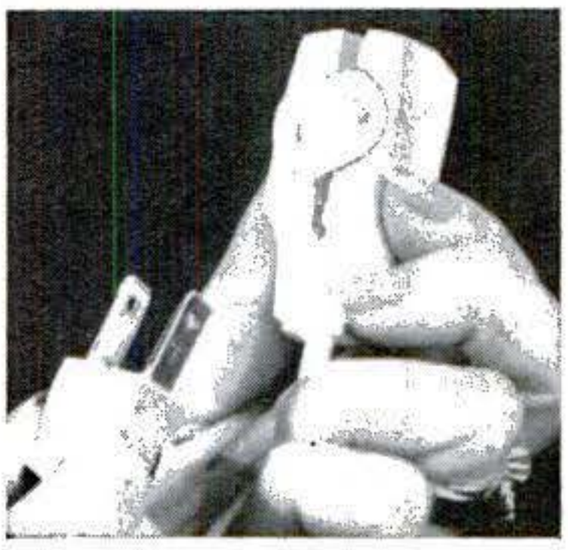


Whirling shower

Granted—the airbrusher used a little artistic license in depicting the effect you get from this rotary shower head. But the nozzle *will* discharge streams of swirling water to give you a quasi-whirlpool bath while you shower. The Rain Jet head fits standard ½-in. pipe, sells at hardware and plumbing-supply stores.

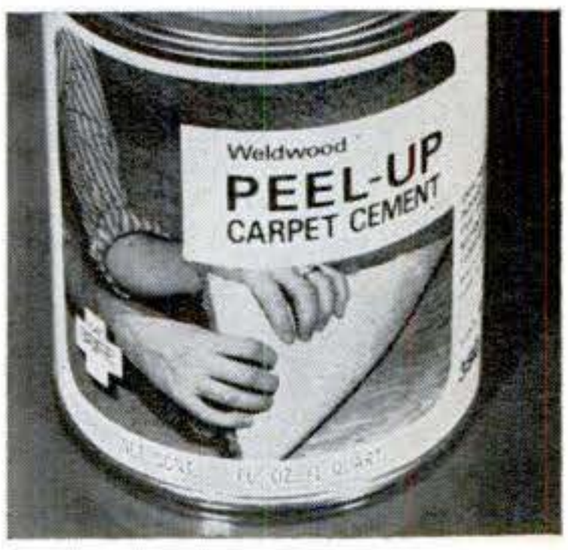
Electric curtains

An electric blanket for your windows? Well, sort of. Actually, it's an electric drapery lining that kills the cold drafts around windows. Just plug it in, and the heat's on. Cameo Curtains, 260 5th Ave., New York, N.Y. 10001, sells it. Price? About $13 for a liner big enough to cover an average-size window.



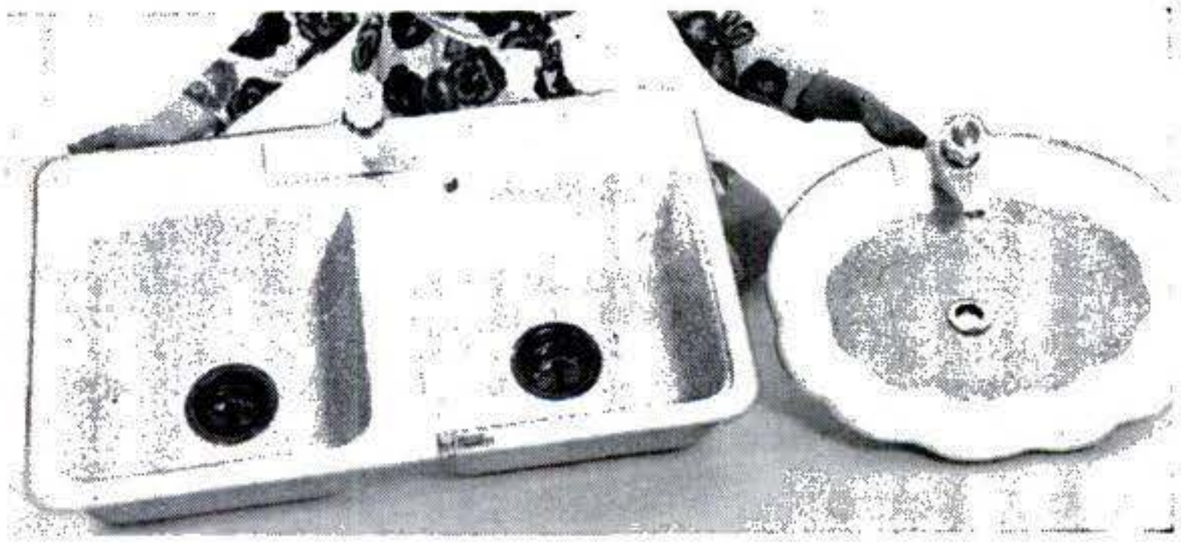
Shock stopper

Want to cheat your kids out of the shock of their lives? Rotary outlet covers on GE's new line of extension cords will do the trick. They keep kids from sticking pins or fingers into the outlet, yet open easily when you twist the prongs of a plug. Cords come in brown and white, in lengths from six to 20 feet.



Reversible cement

It keeps carpets, throw rugs, carpet tiles, and bathroom mats in place, but lets you remove them later for replacement or cleaning. That's because Peel-Up, Weldwood's new carpet adhesive, peels off. Also, it's nontoxic, nonflammable, nonsniffable, and cleans up with water. It comes in quart and gallon cans.



Supersinks

Easy to install, easy to maintain—that's the good news about the new line of Duro-Cast fixtures. They're made of acrylic plastic that won't stain or chip (guaranteed for 1000 months). And they're self-rimming. Construction Components, 3050 W. 71st St., Westminster, Colo. 80030, makes them.

Bell ringer

If you have an electric doorbell, you have part of a fire-alarm system already in place. Telmec provides the other part—the control unit, detectors, and hardware to hook everything up so your doorbell sounds when a fire starts. $79.95 from Telmec, Box 74, Apalachin, N.Y. 13732.

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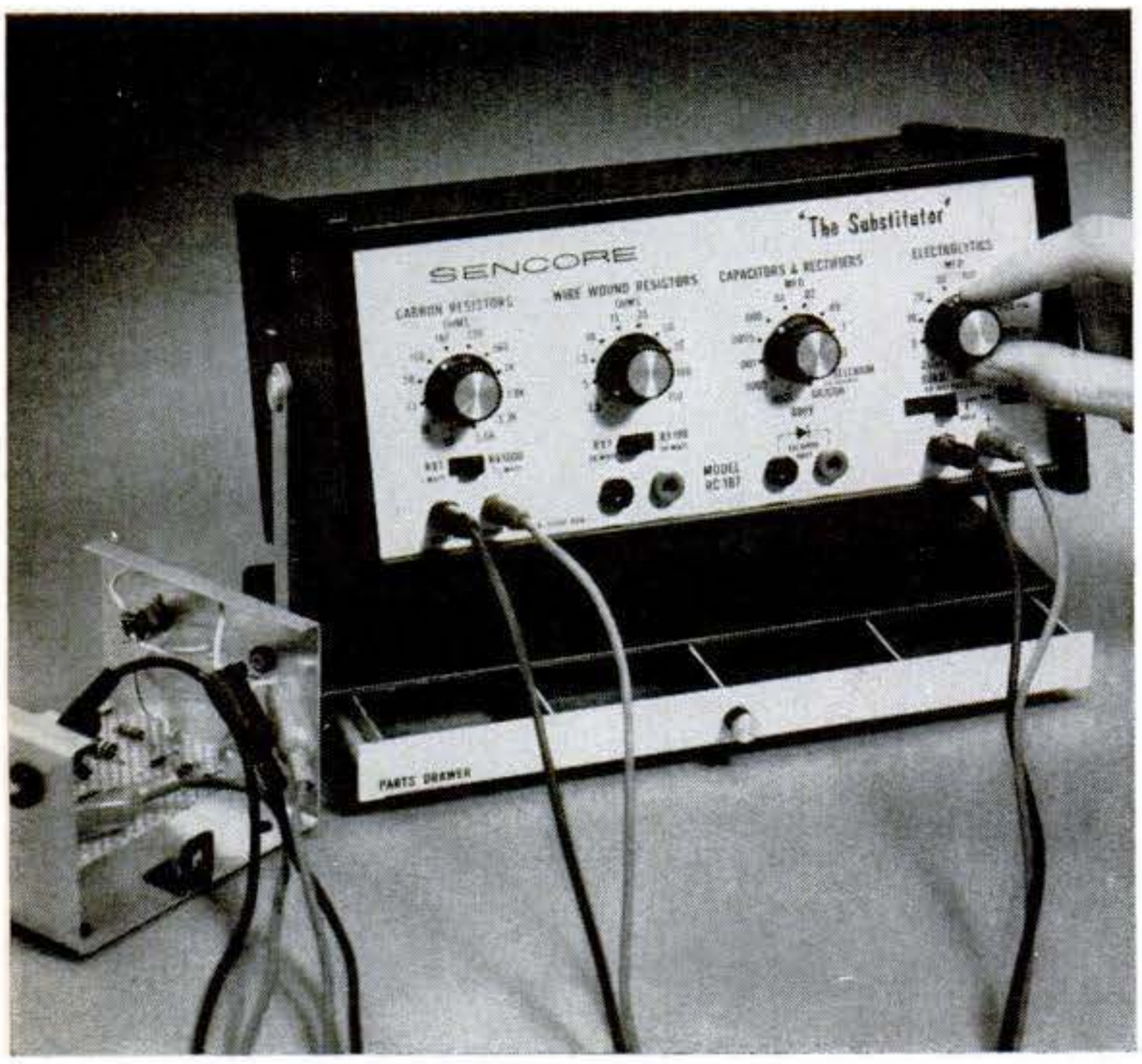
What's New IN ELECTRONICS

Non-tickers

These experimental clocks from RCA's Solid State Division will run for a year on just one set of batteries. Liquid-crystal display and COS/MOS integrated circuits keep power requirements low, battery life long. The clocks aren't available yet, but all the components that make them not tick are.



Sub box

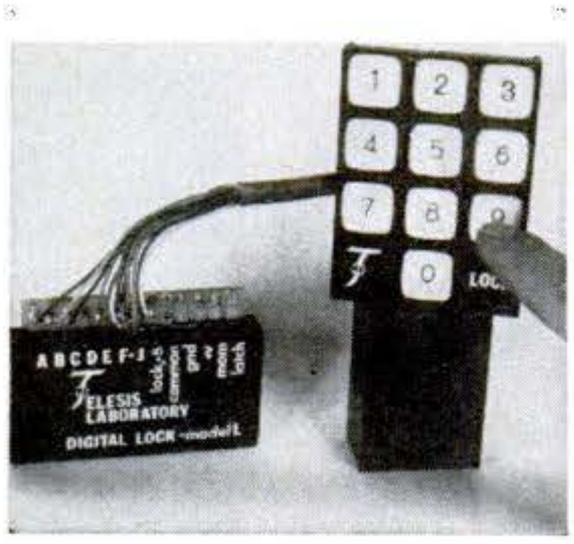
A new component-substitution box from Sencore has them all. Just dial in: carbon and wire-wound resistors, selenium or silicon diode, standard capacitors, and electrolytic caps with large capacity and low voltage for transistor and IC circuits. The Sencore Substitutor is $90.

Black-band color

First set to use Toshiba's new in-line Blackstripe color picture tube is their 13-in. portable. Alternating the color phosphors and opaque black bands is said to increase brightness some 60 percent over conventional tubes. Model C-333 sells for $369.95.

Tape rack

Tired of storing your cassettes in piles, groups, and bunches? Now you can keep 'em neat with this Audiovox Stow-A-Way tape rack. It takes up just seven inches of shelf space, holds up to 32 cassettes on its rotatable lazy-susan base. Price: $9.95 from Audiovox, Hauppauge, N.Y. 11787.

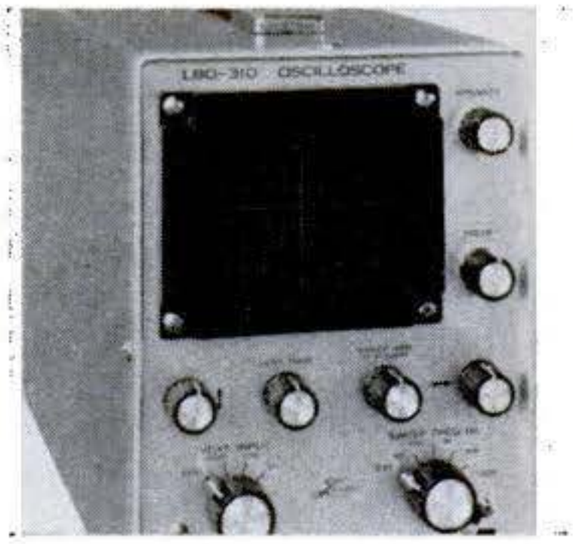


Pushbutton entry

You have security at your fingertips with the Telesis digital lock. Connected to any electromechanical door lock, burglar alarm, or surveillance system, the five-digit programmable code allows only you to enter. Momentary and latched outputs are provided. It's $40 from Telesis Lab., Box 387, Chillicothe, Ohio 45601.

AM binoculars

Keep well informed at your next sporting event with this Binoc/Radio Pak from Bushnell. While you're fine-tuning the binoculars for a better look, an AM radio built into the carrying case fills you in on extra details of the game. Two models: Sportview for general viewing ($68.50) or wide angle ($74.50).



Lightweight scope

Like to take your work home with you? If you're in electronic servicing, this Leader LBO-310 scope makes it easy. It's just 6 by 4 by 13¼ inches in size and weighs 10 pounds. It operates on 110 or 220 VAC, or 12-volt power supply. Price: $199.95. Maker: Leader Instruments, 37-27 27th St., Long Island City, N.Y. 11101.

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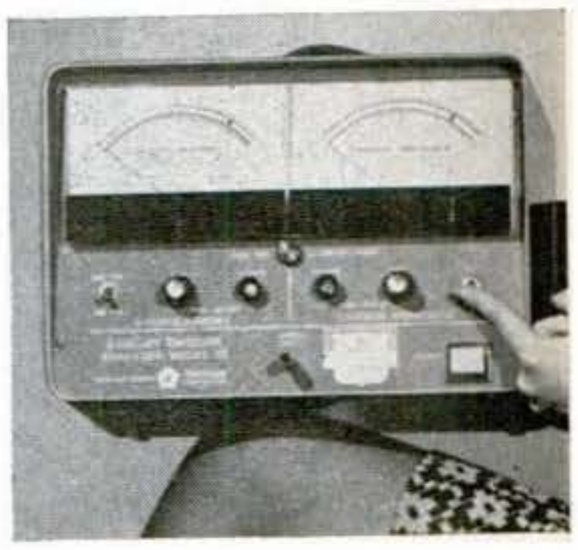
What's New
FOR YOUR CAR

Safety seats

GM now has two sizes of car seats for kids up to about four years old. Children 20 to 40 pounds fit the Child Safety Seat (left) and face forward; infants weighing less than 20 pounds ride in a semireclining position facing rearward. Either one can be used in front or rear seats of most American cars with seat belts.

Emission tester

Soon your local mechanic will know just how much—or how little—emissions your car's exhaust system spews out. Chrysler plans to make an 18-pound analyzer that'll detect hydrocarbon and carbon monoxide emissions. The device will be used by dealers and garages to tune cars.

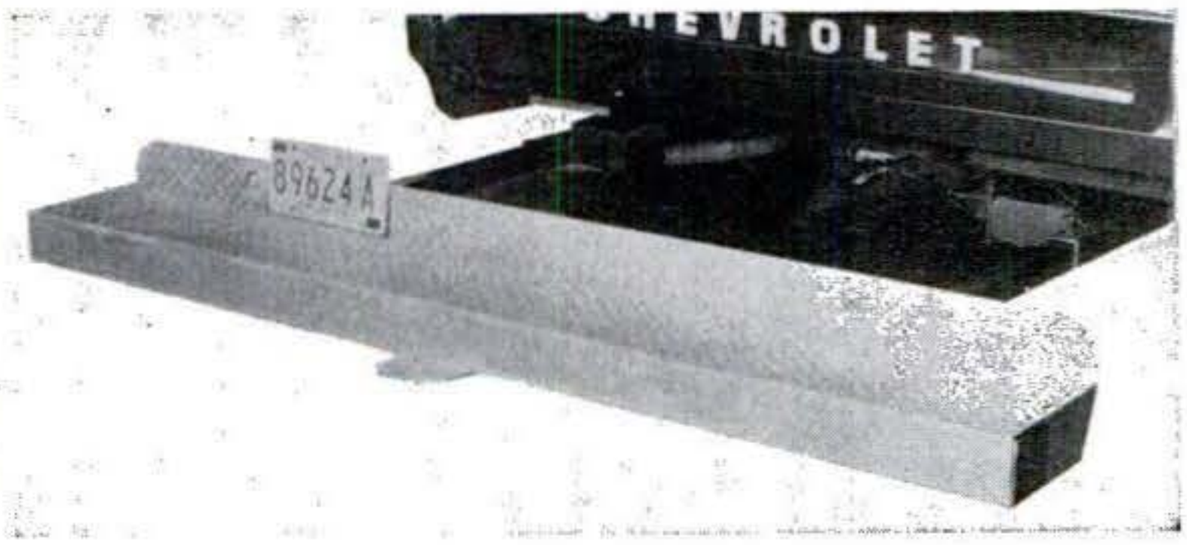


Glass etcher

Car thieves who switch license plates won't like this: a glass-etching system—self-stick numbering stencils and etching fluid. First, your registration number is pressed on the window and painted with the fluid. With the stencils peeled off, it's on for good. Carmark Ltd., 47 Victoria St., London S.W. 1., England.

Mini AM radio

Car radio in the palm of your hand? It's the super-compact Motorola TM573A AM radio. The maker says it's half the size of any pushbutton radio they've ever offered. Push/pull audio output and tone control are included. The solid-state unit will fit in your glove box.



Step bumper

Constructed of heavy-gauge, nonskid steel, the Extension Step Bumper extends your rear bumper, provides a step-up, and accommodates slide-in brackets for campers up to 11 feet. Three models fit most American pickups. Kenco Engineering, Box 726, Middlebury, Ind. 46540.

Ball-joint kit

Now there's a ball-joint repair kit that's as easy to use as greasing your car, says the maker. Shimmy Stop features a resinous compound containing lubricating pigments that quickly cure to a rubber-like solid when the compound is injected into worn ball joints. Superior Industries, 14721 Keswick St., Van Nuys, Calif.

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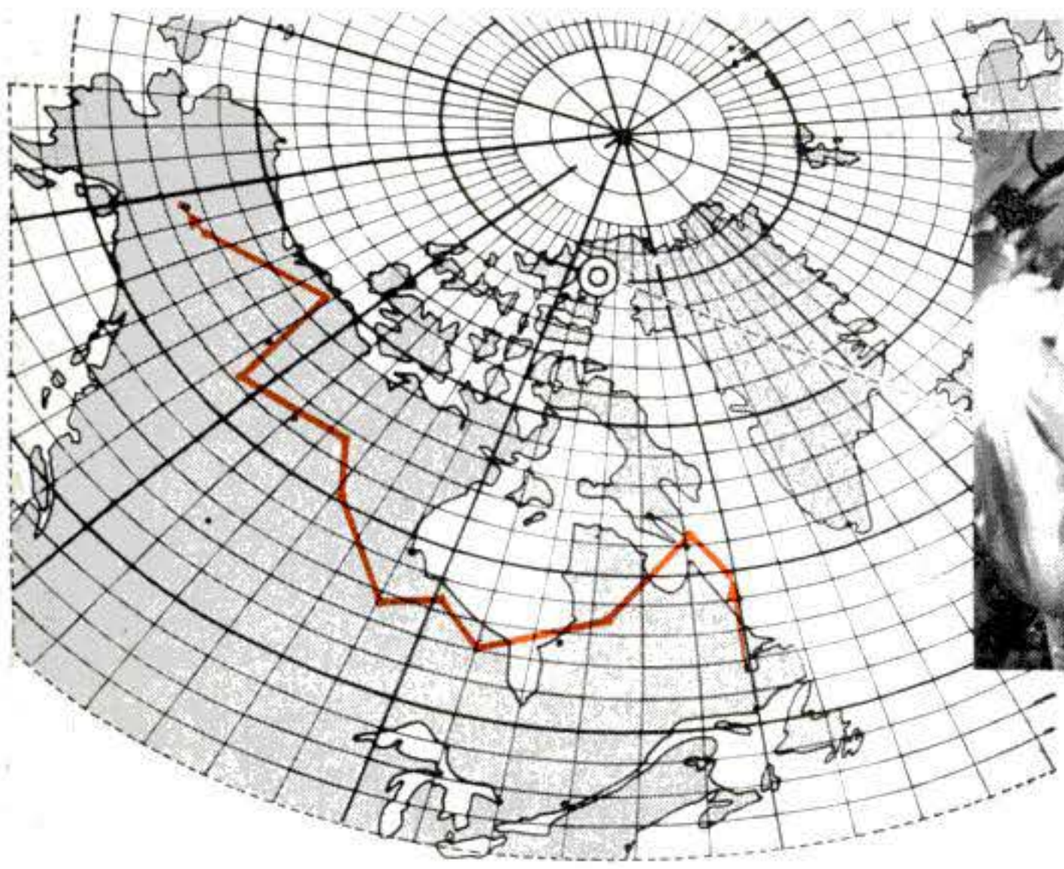
How Science Is Solving the Mystery of the Northern Lights

Long an enigma, this dazzling polar display now appears to flare up when streams of particles from the sun invade the Earth's magnetic field

By ROBERT GANNON ILLUSTRATIONS BY DEAN ELLIS



Chasing the aurora in a research plane

PS Adventure Editor Robert Gannon, at left in photo, talks to mission director James Whalen. Gannon is first reporter to accompany an Air Force research team that has been flying beneath the northern lights for 10 years. Their KC 135 zigzagged 4400 miles from Goose Bay, Labrador, to Fairbanks, Alaska, at a speed that kept them at perpetual midnight for the flight's nine-odd hours. Mission: Photograph and eavesdrop electronically on the swirling aurora and coordinate the data collected by satellites and ground stations.

The face of the postcard-size TV set sputtered with meaningless speckles of snow, while Air Force M/Sgt. James Smith fidgeted with its knobs. Suddenly a sharp, glowing point appeared near one corner. "Ah, there's a star," Smitty said. "And there's another." I glanced out of the plane's window and saw only the wing and surrounding grayness. "We're still a couple of thousand feet from the top of the clouds," he explained, "but the camera is picking up infrared frequencies." The TV camera, mounted atop the plane, pointed straight up.

We weren't looking for stars, though. We were searching for the northern lights, sometimes called the Aurora Borealis. Another star appeared on the screen; two more followed. Then, suddenly, a streak of light swirled across the screen like a sagging G. "Hey, look at that!" said Smitty. "We're out of the clouds and *look* at it; look outside." I hurried to the window and got an extraordinary view of the aurora.

What we were doing was flying a zigzagging, 4400-mile path westward, from Goose Bay, Labrador, near the Atlantic, to Fairbanks, Alaska. It was midnight, and our speed just matched the Earth's turning, so we would *stay* at midnight throughout the flight's 9¼ hours.

Why Air Force interest in the aurora? Because it fouls up communications. When the lights are lively, almost no high-frequency signals can cross the Arctic region. (Line-of-sight uhf and vhf can be used, but hardly anyone is around to hear.)

The basic mechanism of the lights has been fairly well understood for years. They're caused by electrons and protons shot out from the sun. The particles stream into the Earth's atmosphere at a great density—100 million or so per square inch—and collide with atmospheric gas molecules some 50 to 500 miles above the surface, giving off light as they do so. Most activity occurs near the poles because the charged particles are deflected by the Earth's magnetic field elsewhere. (In the south-pole region the effect is called Aurora Australis—the southern lights.)

That's the basic view, anyway. Syun-Ichi Akasofu, of the University of Alaska, probably the most knowing of all aurora scientists, told me "it's much more complicated than that."

What complicates things is that recent satellite measurements of incoming auroral particles show them to be traveling at much higher speeds than the solar wind particles. The altitude of brightest light is usually only about 70 miles, and in order for particles to plunge that far into the atmosphere, they'd have to have been accelerated to considerably higher energies than seem possible.

The secret, physicists conclude, is that most of the particles don't come directly from the sun, but first bypass the Earth, are trapped in the magnetosphere (the region of magnetic field surrounding and trailing behind the Earth, that is pushed there by the solar wind) then somehow are shot back toward Earth like a whip

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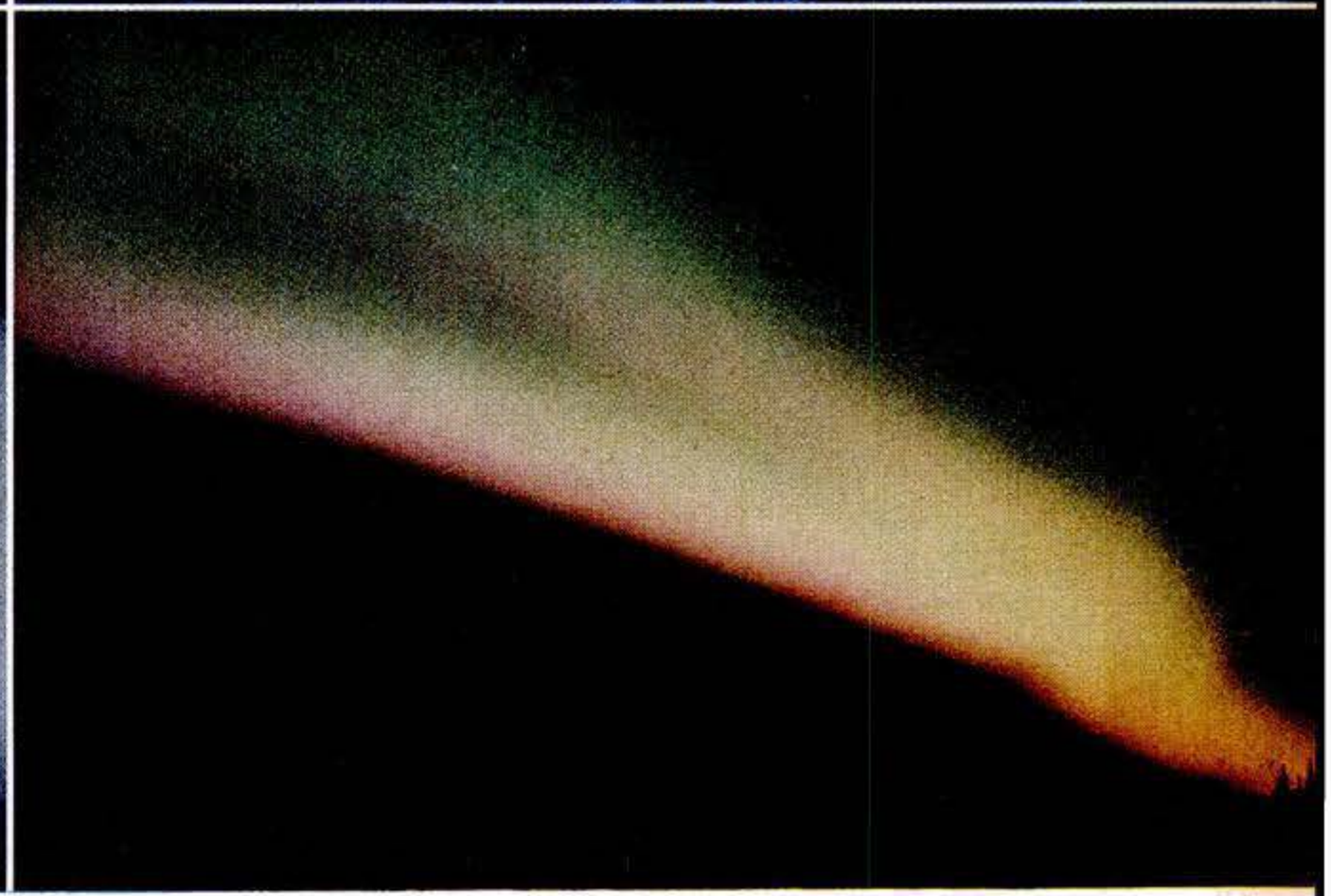

Ever-changing, fantastic shapes of northern lights make them one of nature's most fascinating spectacles. Color most often seen is bluish-green. Colors result when oxygen and nitrogen in air are bombarded by incoming electrons and protons from sun and release radiant energy. In general, blue-green corresponds to excited nitrogen molecule; red to oxygen at about 250 km height; green to oxygen at about 130 km. Other color combinations are seen, but more rarely.

tip to stream down the field lines toward the magnetic poles.

They rarely focus *on* the poles, however, but are brightest a thousand miles south. A dozen years ago a Russian physicist theorized that this zone of highest activity extended all the way around the Earth in a huge, lopsided ring with its lower edge (at midnight) usually above mid-Canada, its top near the Arctic Circle. He called it the *auroral oval,* but not everyone accepted his idea. That is, until satellite photos showed it sitting there, like a halo.

Now we were underneath this halo, below the auroral oval, Alaska-bound.

Training for the trip. Back at the Air Force Cambridge (Mass.) Research Lab headquarters, we had all gone through survival training. (Don't touch metal or you'll lose your skin; wind-chill factor is 10 times greater if you're sweaty; snow blindness feels like a hundred cinders in the eyes; don't try walking to civilization alone. Fat chance.) I was fitted with personal helmet, parachute, and oxygen equipment, outfitted with Arctic gear, and told that temperatures in Fairbanks, our destination, usually were in the minus 40s or 50s this time of year. We flew to Goose Bay, then the next night, taking off in a roaring snowstorm, began the search.

Now our speed, as we broke through the clouds, was 482 mph, our altitude, 31,500 ft. The temperature outside was -57 F.

Smitty yelled again for me to look. I did, and there spread out before me was the aurora. I was surprised. I had expected it to be very colorful. It wasn't; it was the tint of blue-green moonlight. But it was awesome, because it was *huge*—stretched all across the sky. And *active*—things going on all over.

Off to the left stood a greenish pipe organ, a row of swords, a picket fence with each picket changing its length. Directly in front, a spiraling swarm of luminous bees swirled off into the distance. And to the right, more pickets—only here they looked like hundreds of parallel searchlight beams, each varying in intensity. Then they suddenly fanned out—no movement, exactly; the original beams simply faded out as others took their place. I moved to the opposite window. Out there, more lights; but an overall glow like a city in the distance, or a slow-motion thunderstorm. People have even turned in fire alarms, believing a nearby town aflame.

Ringing the changes. Then it doesn't look like any of that, but like greenish oil on a pond. No, like moving smoke. You keep thinking of smoke because it's familiar. But what you see doesn't *act* like smoke. It doesn't move from one spot to another but fades and brightens —a little like those movie marquees whose blinking lights make you think they're moving.

Now the whole sky has a permanent wave—shifting to Shirley Temple curls. They begin to flutter, like a curtain in the wind. I glance away, and when I look

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back the curtains have formed a huge ring around the plane. It slowly tightens. Eerie.

Walking from window to window, checking the recording machinery, stopping every so often to explain something to me was Dr. James Whalen, 45, ex-nuclear physicist, now one of the world's experts on the aurora, and this mission's scientific director. He's made dozens of these flights over the five years he's been with AFCRL. He's seen it all before, I figured.

"But each flight is different," he commented. "And this time in particular—I don't think I've ever seen so much going on at one time."

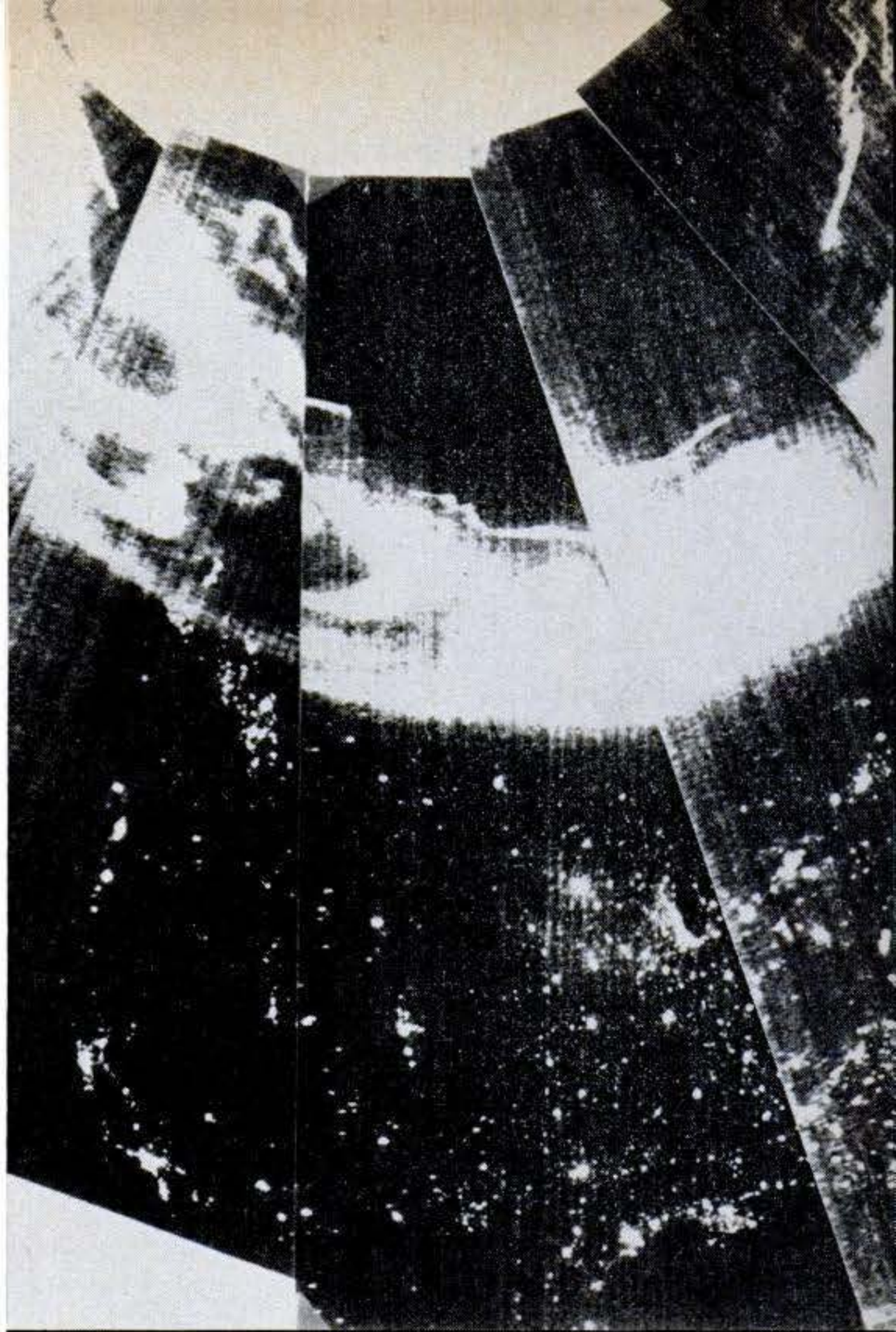
A band of light stretched before us now. "That's about 150 kilometers high and maybe 1000 across, I'd guess," he said. "Notice it's sharply defined on the lower edge, and hazy at the top? That's a common pattern. That shows that the particles causing it are of varying energy levels, and that the maximum penetration of the atmosphere is very clearly defined; they are able to plunge to a certain set altitude, and absolutely no more. Why these energies? Who knows? Just one of the mysteries."

Another mystery is that of the pulsations, the "breathings," of the aurora. At certain times the whole oval expands and becomes more active. One set of rhythms is closely tied in with the sun. When its surface is very agitated, when solar flares stretch outward, you can expect wild aurora displays a day or two later. These last a couple of days, then usually quiet for a week—then more activity. Such storms occur every 27 days or so, on average.

The substorm. In the mid 60s, scientists discovered another rhythm—intense activity for about two hours, then little, then another spate of brilliance two hours later. Comments Whalen: "Ideas abound as to the cause of the substorm, but nobody has even a solid theory.

"A whole lot of other things don't fit either. For example, about an hour before a substorm starts, in the magnetic field between Earth and the sun, there seems to be a reversal of the magnetic field. If a compass were out there it might be pointing north. Then suddenly it turns south—and that means a substorm will probably

[*Continued on page 134*]



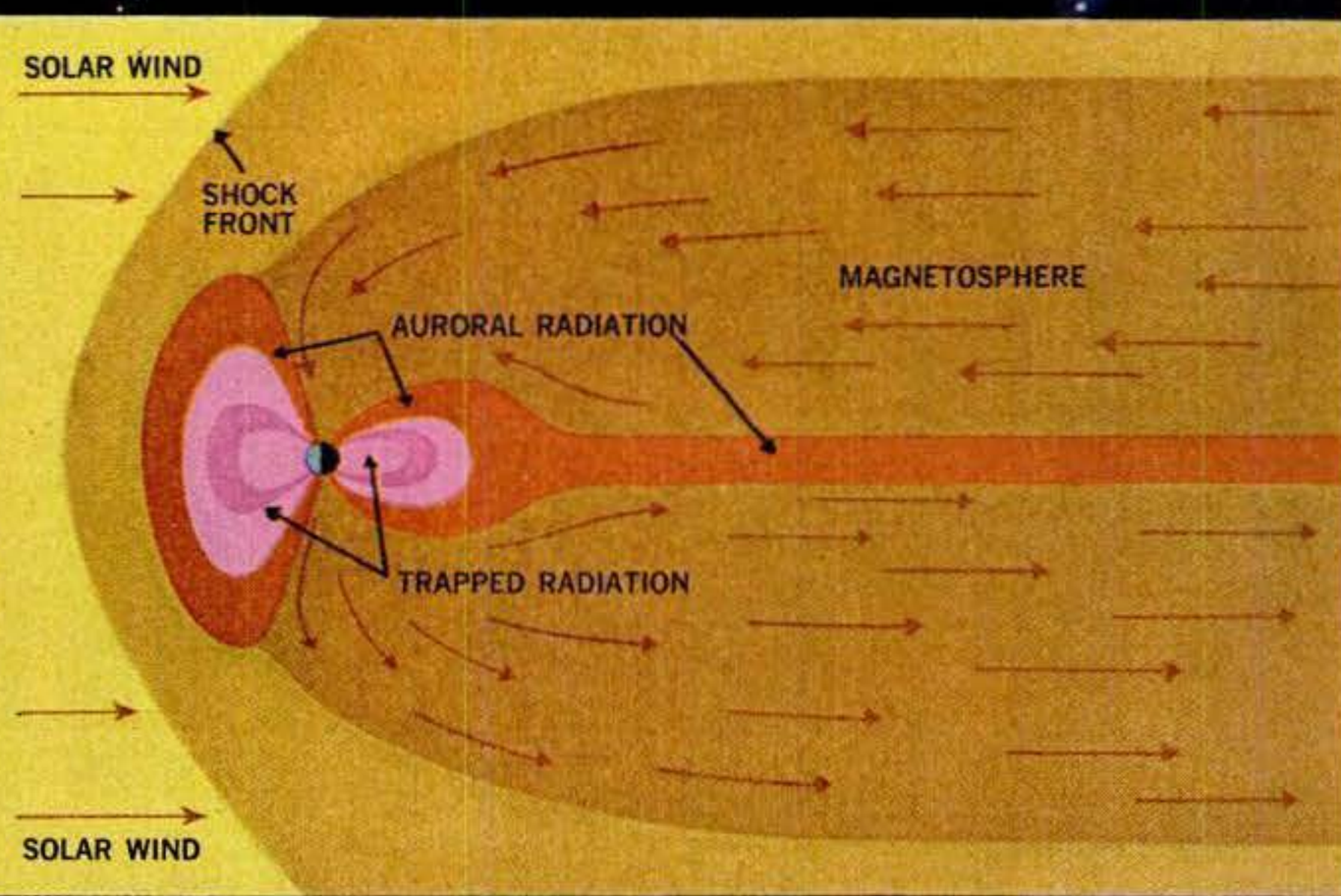
Composite photo of northern lights as seen from space pieced together from a series of Air Force shots made b weather satellite. The aurora stretches across Canada. Note lights of U.S. cities stand out in this view of the North Amer continent taken on a night when there was no reflected mo light. Camera lens could not "see" objects less than two m across. Five orbits of satellite produced photo.

All-sky photo of swirling northern lights was taken at U Alaska's Ft. Yukon Observatory. Tree is at lower right. Expos three seconds on special high-speed film.

Northern lights—fact and fiction

- **How often does the aurora occur?** All the time—even in daylight—but it isn't seen terribly often in the U.S. In Boston, for example, it occurs about three percent of the time, or once a month. But it may be so faint that city lights obscure it. Or clouds may cover it. Or you simply may not look up. Southern U.S. sky watchers see the lights about once a year as a dark glow near the horizon. In 1958, a blood red aurora appeared as far south as Mexico.
- **Is it true that the lights make sounds,** sometimes? Maybe, but scientists haven't heard them. University of Alaska aurora-expert Dr. T. Neil Davis told me that several friends, and his wife, *have* heard such sounds. He says it's possible that "the sensation is being created within the individual by some physical mechanism not involving sound waves per se."
- **Is it true that the aurora causes blackouts** of electricity sometimes? Yes. High current flow in the atmosphere occasionally, through induction, throws power-plant breakers on the ground.
- **Why isn't the aurora more colorful?** It is, but we can't see it. Low-level light is detected only by the rods in our eyes, not the cones—and rods don't perceive color. Only when the aurora gets really bright do the cones come into use to make out the greens and reds.—*R.G.*

Auroral oval—zone of northern lights' maximum activity—is seen here as huge band lop-sidedly ringing Earth's geomagnetic pole. Intense solar storms can shift oval closer to equator. The lights, visible only at night, glow when electrically charged particles shot from the sun (solar wind) collide with gas molecules in our atmosphere. Scientists think that these particles are first trapped in the magnetosphere (right), region of concentrated magnetic field, then whipped back toward Earth at speeds higher than particles in the solar wind itself.



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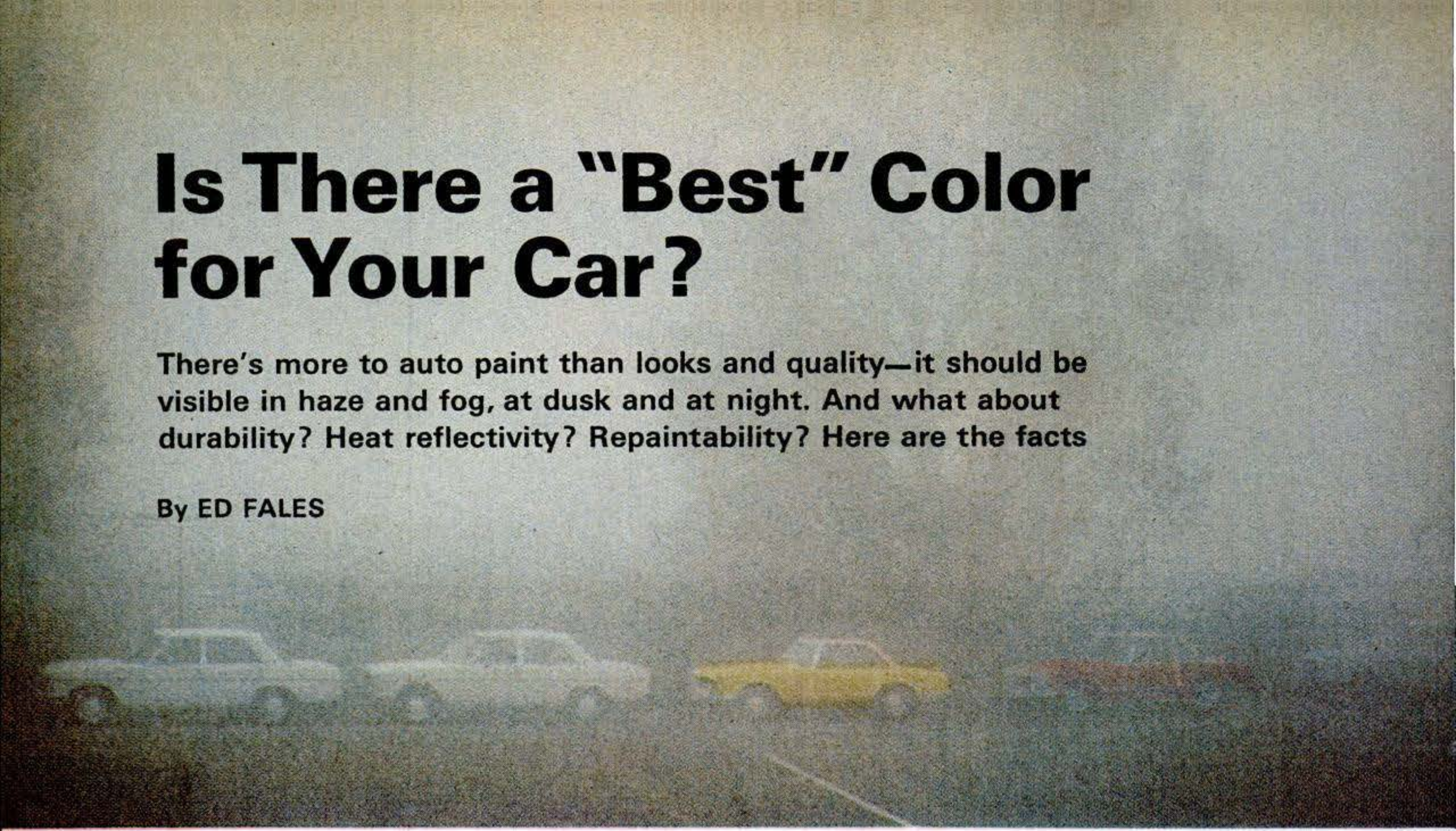
Is There a "Best" Color for Your Car?

There's more to auto paint than looks and quality—it should be visible in haze and fog, at dusk and at night. And what about durability? Heat reflectivity? Repaintability? Here are the facts

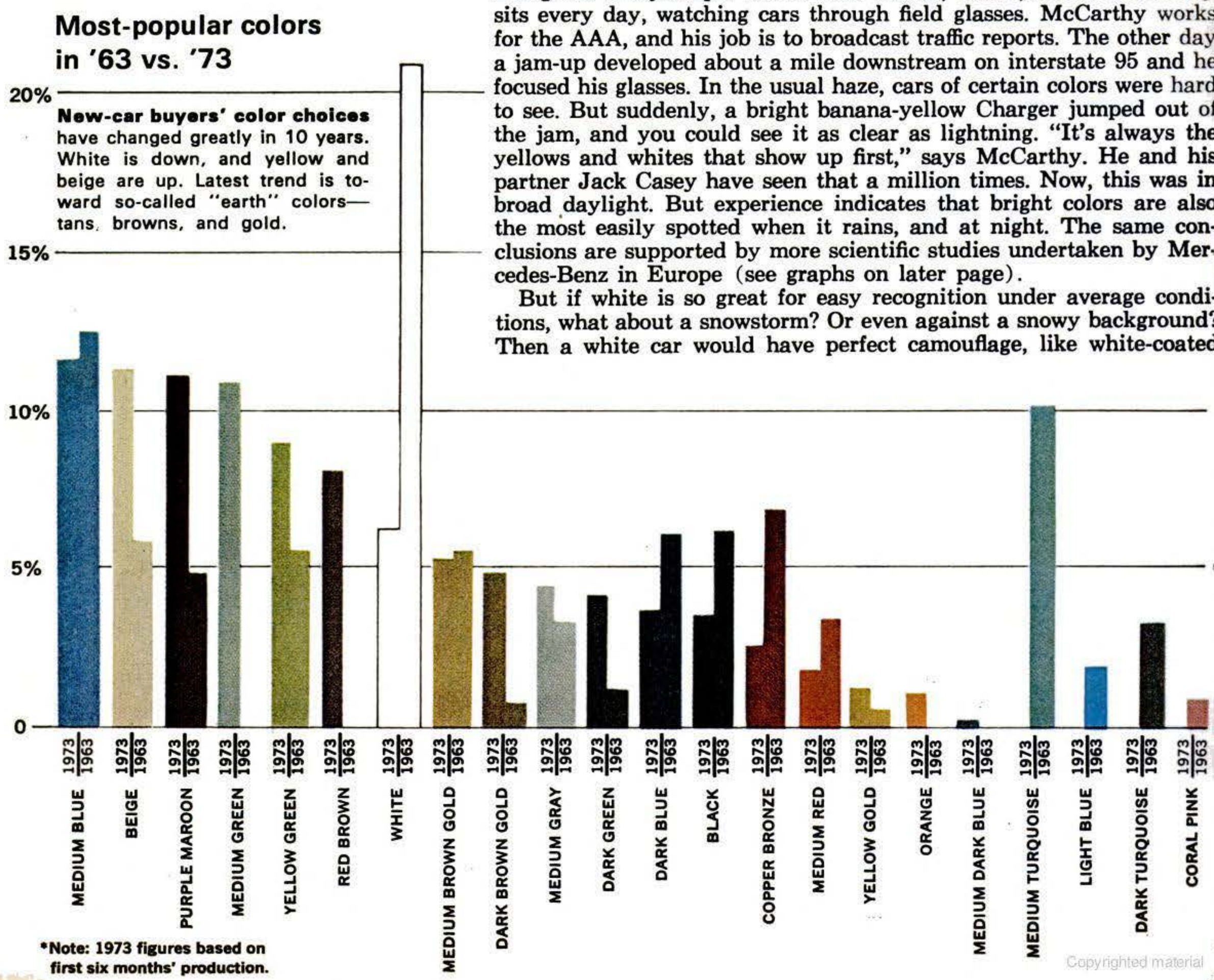
By ED FALES



Five cars lined up in a mist (left to right): white, ivory, orange, red, sky blue. Ivory shines; red is blacked out.

High in a skyscraper above New Haven, Conn., Frank McCarthy sits every day, watching cars through field glasses. McCarthy works for the AAA, and his job is to broadcast traffic reports. The other day a jam-up developed about a mile downstream on interstate 95 and he focused his glasses. In the usual haze, cars of certain colors were hard to see. But suddenly, a bright banana-yellow Charger jumped out of the jam, and you could see it as clear as lightning. "It's always the yellows and whites that show up first," says McCarthy. He and his partner Jack Casey have seen that a million times. Now, this was in broad daylight. But experience indicates that bright colors are also the most easily spotted when it rains, and at night. The same conclusions are supported by more scientific studies undertaken by Mercedes-Benz in Europe (see graphs on later page).

But if white is so great for easy recognition under average conditions, what about a snowstorm? Or even against a snowy background? Then a white car would have perfect camouflage, like white-coated



*Note: 1973 figures based on first six months' production.

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White Mercedes stands out in twilight when other colors fade. Weather is clear; light condition: open shade.

On an overcast day, the Day-Glo orange paint stands out from other colors, and can be seen at greater distance.

soldiers invading an arctic island. "There is no proof that certain colors are safer than others," says Roy C. Haeusler, Chrysler Corporation's chief engineer of auto safety and security. But he adds: "I agree with the general opinion that brighter colors are easier to see, but we have no scientific studies to prove they are always best—nor do we have any proof to the contrary."

Auto dealers report that quite a few buyers come in today asking for cars that "can be seen." What they end up with, however, is not always the car that is most easily seen, but a car with a color they think of as bright and noticeable. Since fire engines are red, many people believe that's a high-visibility color, while Mercedes-Benz rates it very low in recognition value. This misapprehension seems to affect Pontiac buyers more than others. In the '73 models, Pontiac buyers chose deep florentine red and the somewhat brighter buccaneer red as the most popular colors. A year ago, green was the

Continued

A clean car is more visible. Above: same car, same day, before and after washing.

Yellow paint at night reflects light from headlights of another car, though tail end, outside light beam, is invisible.

Red paint at night seems to soak up illumination from car headlights. Only chrome and brightwork make it visible.

White car tends to disappear against snow background. In snow country, white color could be a disadvantage.

Paintshop assembly line: Sheet metal 0.6-0.9mm thick is covered with four-six coats for combined 0.1mm thickness.

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Chrysler's Roy C. Haeusler: "My next car will be painted maroon with a

"It's always the yellows and whites that show up first," says Frank McCarthy (right), who monitors cars from high up.

favorite color of Pontiac buyers. Maybe there's no accounting for personal preference.

However, Dick Teague, American Motors vice-president in charge of styling, has made some studies that show color popularity reflecting the social mood. "Colors that are growing in popularity by leaps and bounds," says Teague, "are earth colors—tans, browns, and gold. We think that's because of the ecology kick."

As for fire engines, some cities have been experimenting with other colors, such as yellow or—believe it or not—chartreuse (yellow-green) with considerable success. Red paint just gets lost against traffic, surrounding buildings, neon signs, billboards, and even the countryside.

Red is camouflaged because there is a lot more red around us than we realize. And at night, a red fire engine just goes *black*! Indiana University's vision expert, Dr. Merrill J. Allen, confirms this: "Red turns so black at night that it's lethal."

The fact that school buses are yellow is not based only on visibility, but on the fact that American road users are conditioned to yellow vehicles being slow-moving or stationary (highway construction and maintenance equipment) or particularly associated with the presence of children. In any case, a big "caution" mark.

Bright colors, however, may create another visibility problem: glare. Sunlight or other light sources may be reflected from the hood and cowl, and obscure or obstruct part of the driver's view. That's why race and rally cars usually have matt black or other "flat" (nonreflective) paint jobs on the hood. Perhaps it's enough to have part of your car white, yellow, or orange. "My present cars are white and gold," says Chrysler's Haeusler, and then confesses: "My next car will be maroon with a white vinyl top."

Visibility isn't the only thing to consider. Which colors fade and grow dull? "Since the arrival of acrylic paints," says AMC's Dick Teague, "that problem is not so severe as in the past. Before, maroon-colored cars —and some dark blues—used to blush badly after two to three years because the ultraviolet rays in the sun would attack these colors. Now, these colors hold up as well as others." But any color can fade. You don't have to worry too much about that if you wax your car—when it's a year old, and once a year after that. Even some grays and greens can fade. But metallic paints have special problems.

Protruding aluminum particles. We asked Dudley Smart, manager of the color and fabrics studio at Chrysler Corp., about those problems. "Metallic paints have aluminum particles held in suspension in the paint," he explained, "and pieces of them sometimes protrude through the top coat of paint." "In addition," says Dick Teague, "aluminum flakes can 'mottle' in the paint." This becomes most apparent if you use power buffing often or heavily. That's because you are removing patches of the top coat to let the aluminum flakes through to the surface. If this happens, the paint makers say, you can brighten up the dull spots with a mild abrasive polish. *Then* wax. All colors hold better if waxed.

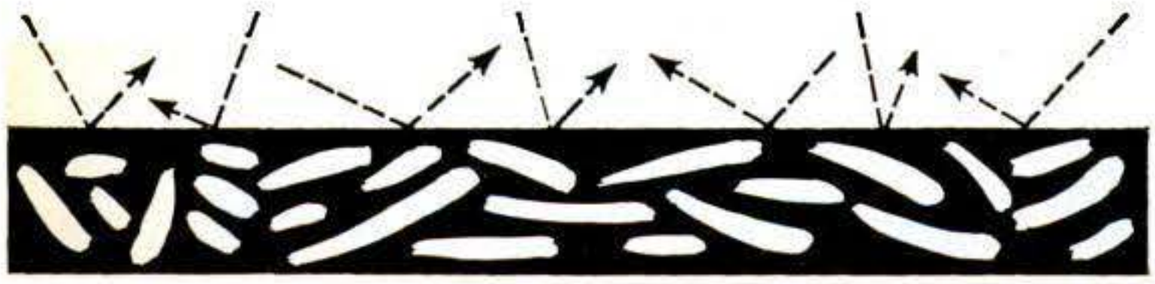
Chrysler tests all its paints under the most grueling conditions they can invent: no waxing, then 24 months in Florida exposed to salt spray and high-intensity sun in rapidly recurring cycles. No paint goes into production on any Chrysler product that has not withstood this test.

Can you match the paint? Suppose your car gets bumped or scratched? This can be a big problem. Some paints are easy to match, some are difficult, and others just plain impossible. A poor match, of course, cuts your car's resale value. And a *perfect* match is almost impossible to get. Even "factory" paint isn't 100-percent uniform. Good paintshop men like George Ranalli of Branford, Conn., tell me that the auto makers aren't always matching colors right—especially the new and popular golds.

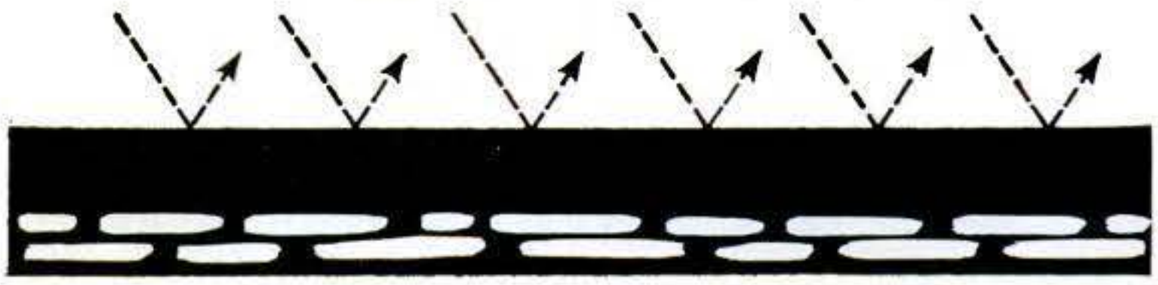
And a Detroit undercoating engineer told me: "Don't think for a minute that all the paint on your new car is the same." Many cars get paint first-aid after coming off the assembly line because of body damage, a paint flaw, or incomplete painting. The last-minute repair paint, however, doesn't go through the usual bake shop. "When we clean one of these cars with mineral spirits, we sometimes find this paint coming off on the cloth," the engineer said.

So, when you buy a new car, have a good look *all around* at the paint, especially if it's metallic. The older types of nonmetallic paints, usually called "solid" paints, are much easier to match. Most foreign cars use solid paints, and all domestic auto makers offer several solid paints.

Why metallics are tough to match. The metallics (also called "polys" or polychromatics) are far more complex. Some whites contain aluminum flakes plus *four* colors, including, believe it or not, red. All of these



Dry spray: metal particles in paint are trapped in haphazard pattern, giving to automobiles a high-metallic finish.



Wet spray: metal particles in paint settle in a parallel pattern, giving a strong pigment color effect to finish.

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white vinyl top"

must be carefully metered out and mixed. And some paints contain as many as 11 different pigments. In addition, there are different amounts and different sizes of aluminum flakes. Any deviation in the color mix, the percentage of flakes, and even the temperature and humidity can make a difference. So can the paintshop man. One man may give your car an entirely different tone from another man using the exact same mixture and spray gun.

Most cars with metallic paint are sprayed "wet." That means the spray has high thinner or reducer content in relation to the air pressure. It also means that the repair-paint mix must be "wet." A "dry" coat turns out lighter, with a more metallic look. It can be covered by several layers of "wet" spray, but hitting the right degree of wetness right off gives the best uniformity and matching.

In general, when matching colors, according to a careful, experienced paint man, Don Perry of Ashley Falls, Mass., you should bear in mind:

- Easiest colors to match are orange, medium blue, dark blue, beige, dark green, and gray with low metallic content.
- Toughest to match are red, light blue, yellow and gold, dark brown, copper bronze, medium green, and high-metallic gray.

Then there's the matter of nonstandard matches of interior trim and exterior paint. The auto makers will give you any combination you want, but used-car dealers prefer standard combinations. Most nonstandard combinations will look odd to individual used-car buyers, too, so for best resale value, you are advised to stick to standard color combinations.

Buying a new car? Before that gleaming surface overwhelms you, ask yourself these questions:

Will your color stand spot-repairing? That's a $10 touch-up, as opposed to $25-$100 area painting. In general, acrylic lacquer (General Motors) spot-patches easier than acrylic enamel (used by the other car makers). But that's a matter of material specification, not of color. The colors that spot-patch best, whether lacquer or enamel, are the nonmetallic blues, yellows, or greens.

Will it stay clean? Dark colors show dirt mostly as light stains. White resists dust, but streaks badly. The cleanest colors seem to be medium and eggshell green, yellow-green, and gold to medium-brown.

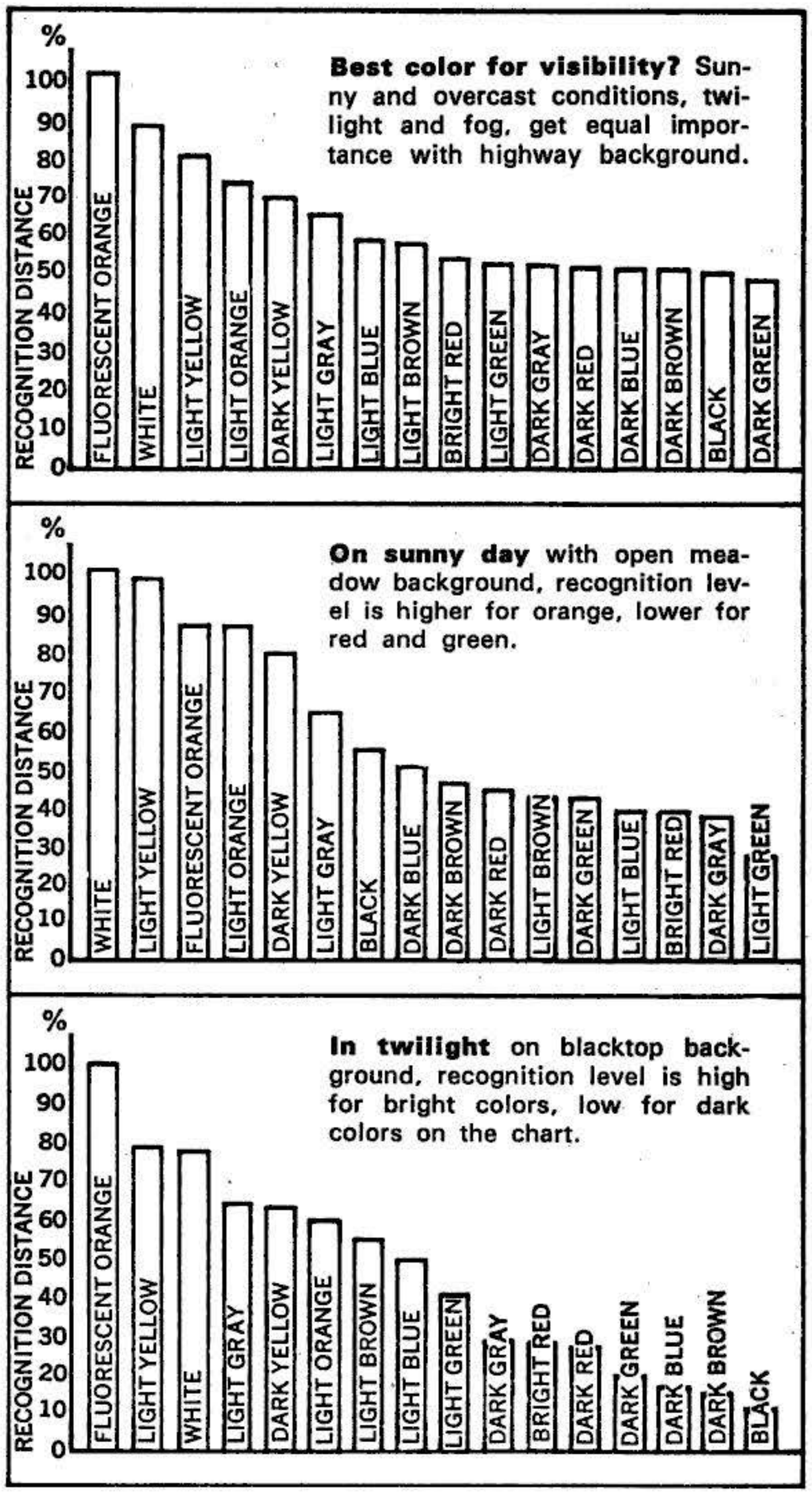
Will it show rust? If you keep the car, that is. If you intend to keep the car for four or five years, you don't want white. Rust just ruins white. The best is gold, which camouflages even "five-year rust."

Will it reflect heat? Dark paints soak up the heat, while light paints reject it. A dark-blue car parked in the sun will be warmer inside at the end of the day than a bright yellow car parked next to it. That means you'll be hotter, or your air-conditioning system must work harder.

What will the paint cost? This can make quite a difference on a big repair, or a complete paint job. In general, the more flakes you can see sparkling in a color, the higher the price. Exotic pigments like copper-bronze and yellow-gold can go up to $19 a pound. Some basic pigments are only 13 cents a pound.

Will you lose on the trade-in? A dealer will spot a mismatch and discount it heavily. But even good-quality paint can be hard to sell if it's the wrong color. Black moves very slowly on used-car lots. Big cars painted dark green or dark brown are also slow movers.

Popular and "one-year" colors. "Some colors move very fast—like greens, or blues, or golds," one dealer told me. "I'd advise my son to buy blue or



Best color for visibility? Sunny and overcast conditions, twilight and fog, get equal importance with highway background.

On sunny day with open meadow background, recognition level is higher for orange, lower for red and green.

In twilight on blacktop background, recognition level is high for bright colors, low for dark colors on the chart.

green. Those colors have been around and have stayed around. There are some buyers we call 'blue buyers' because they never want anything else. But a 'different' color has to have special appeal. This is where small cars with hot colors look good.

"If we get a color without appeal, we knock off $100 or more immediately." But—hold your hat—one color causes this dealer automatically to knock off several hundred dollars. It's *red*. Why? "Some people buy red and get tired of it. And then, too, you have to keep a red car sparkling clean or it looks old." One color that even Detroit cautions you about is what they call the sudden "impact" or "one-year" colors—the overnight sensations. (Example: some purples.) One day it's the rage, next day you can't give it away. In general, the easiest cars to trade or sell are green, blue, orange, gold, and bronze.

Conclusion: The evidence is strongly in favor of bright-colored cars in established tones, with nonmetallic paints. If you still want a dark car, get plenty of chrome and brightwork on it, and make it a rule to drive with your lights on so other road users can see you—even in broad daylight. Or consider the white-vinyl roof. It's easy to clean, doesn't hold the heat, and improves the recognition level. PS

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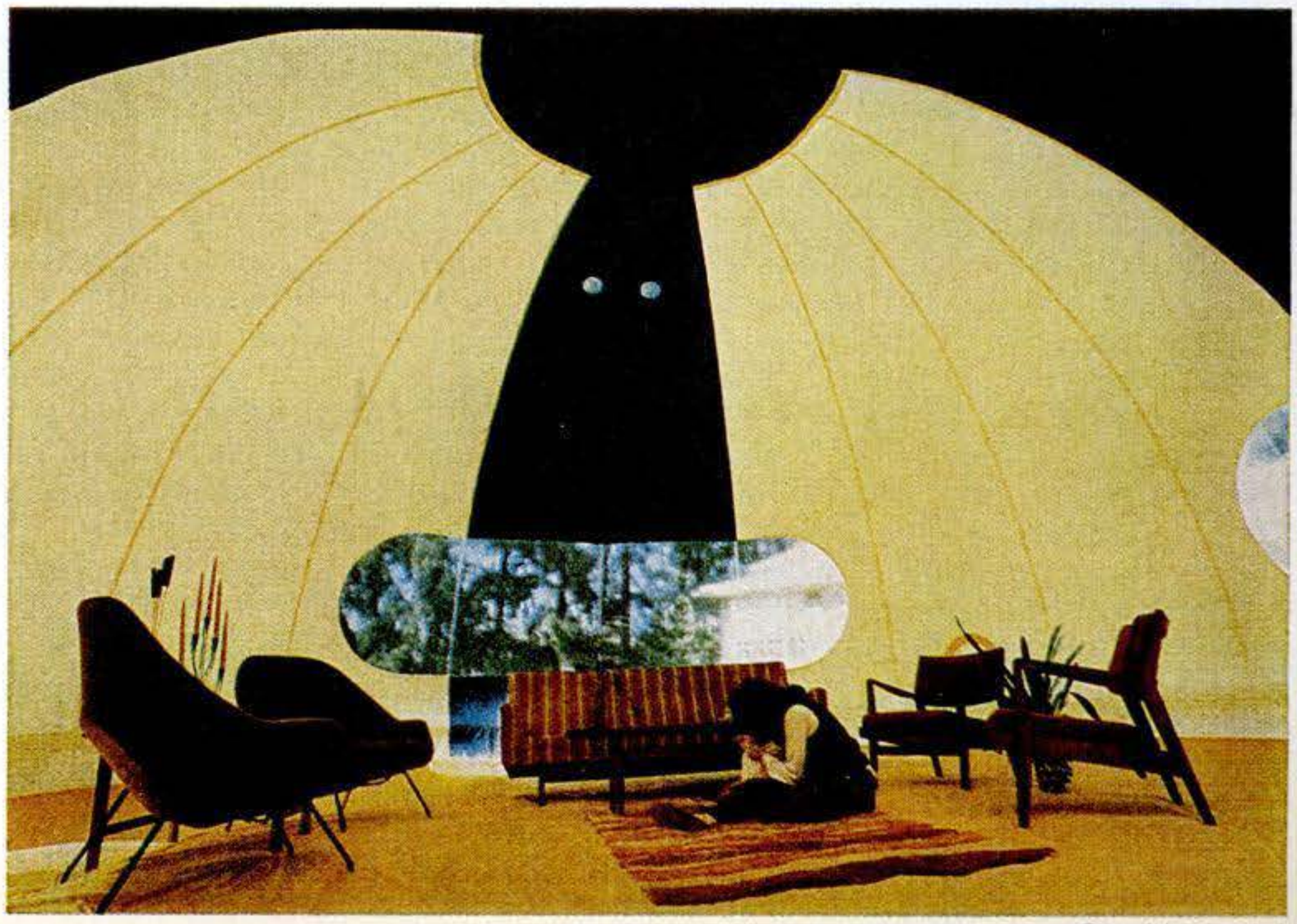
Your Own Inflatable Dome:

Prototype 25-footer is supported by small squirrel-cage fan. You can order kits in your choice of colors.

Simple slit-type door is closed with a five-foot zipper. Air building will remain inflated even with door left open. Spacious, open feeling is a big attraction of dome living, as the view at right proves. Nylon-reinforced vinyl is tough enough for use as the floor.



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Make It from a Kit

PS brings bubble buildings into the realm of the do-it-yourselfer: Take your choice of kits in three sizes—or start from scratch if you like

By A. J. HAND / *PS Home Workshop Editor*

You've read about the new air-supported buildings that can cover hundreds of acres [PS, Mar. '73]. Now take a look at some pneumatics designed with you in mind. They're inexpensive, easy to build, and adaptable to a whole range of uses.

The basic single-skin plastic dome, inflated by a small blower, can be used as a studio, greenhouse, pool cover, outdoor rec room, camping or vacation shelter, portable classroom, or storage facility.

The 25-footer shown here packs down small enough to fit your car's trunk. Two men can set it up and inflate it in less than 30 minutes. Total weight is under 300 pounds.

If the 25-footer doesn't fit your size needs, how about a 16- or a 34-footer? All three are available as kits. None of these is your size? Then you can design your own with help from a plans booklet.

To bring you these kits, and the plans booklet, we turned to Poor Willie Productions—a Boston-based design-development firm. They produced our prototype 25-footer, they're supplying the kits, and they created the instruction booklet, too.

The basic skin used for all the dome kits is 12-mil vinyl film. Colored sections are nylon-reinforced Dura-Tuff (Duracote Corp., Ravenna, Ohio). Clear sections are Union Carbide's Krene, a special vinyl formulated for greenhouses.

Both films are extremely tough. Outdoor lifespan runs from five to 10 years. Rips and punctures are rare, but easy to fix with vinyl patches and cement.

The gore design. This is one of many solutions to the problem of building a dome from a membrane fabric that is initially flat.

The dome is broken down into small, curved sections called gores. When inflated, the gores take on a compound curvature, flowing smoothly into a dome. These gores are welded together with a heat-resistant vinyl adhesive and solvent: Bostik #7130 and methyl ethyl ketone (MEK).

The door. Although large pneumatics often require air locks at doors to prevent depressurization

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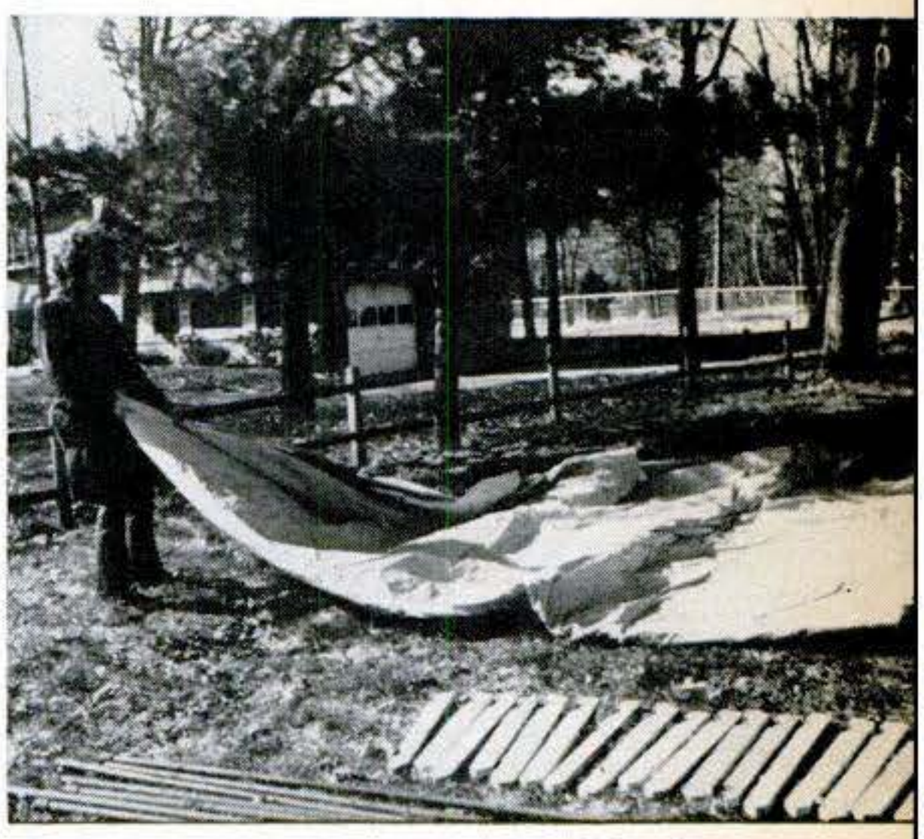
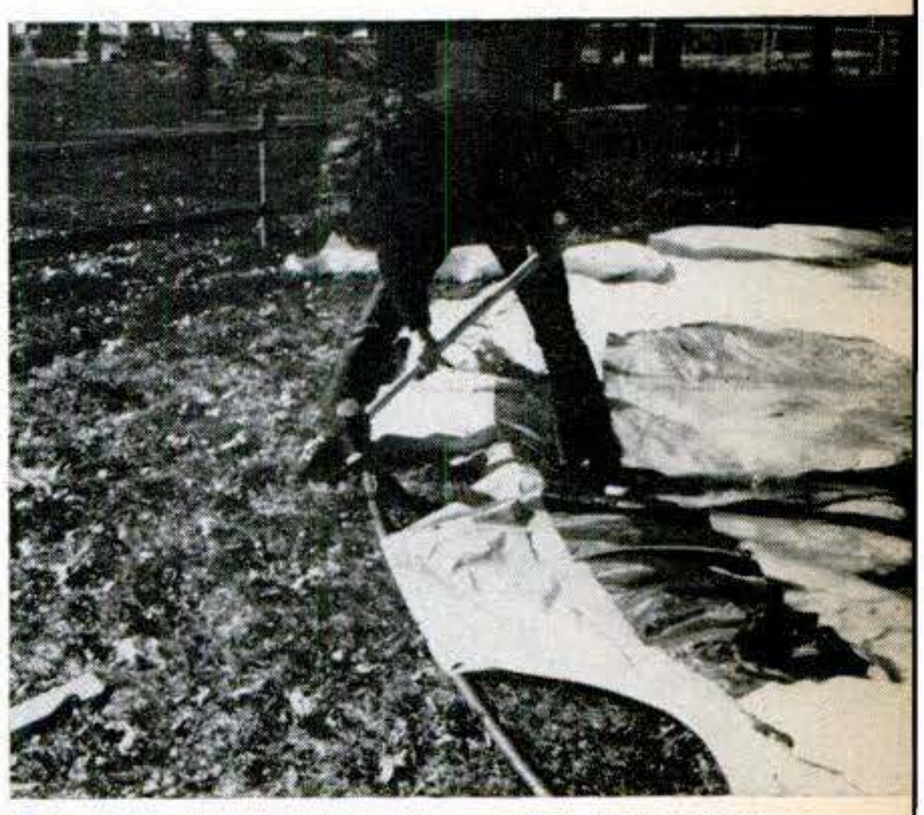
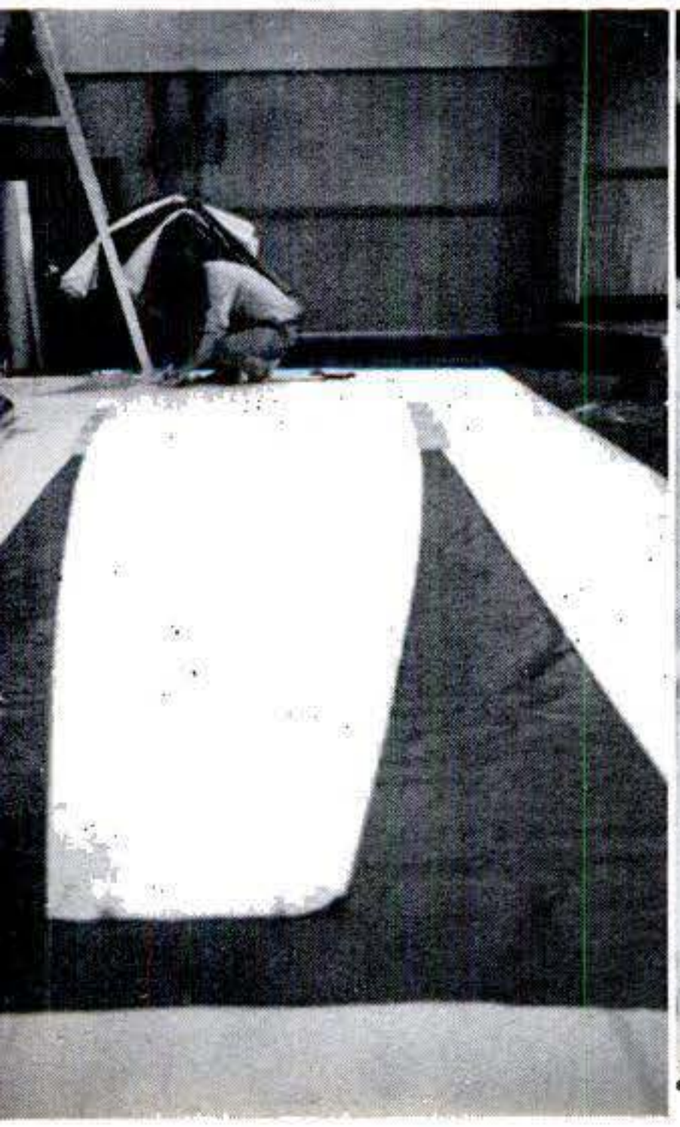


Setting up the dome is a 30-minute job for a two-man crew. You start by spreading the dome out in a circle.



Secure dome in place by threading plastic water pipe through the catenary sleeve, driving stakes down over pipe.



Hook up the blower and turn it on. Dome is inflated in minutes. Use a four-way switch on blower to control output.

Gore layout and cutting requires some 18 feet of open space. Work inside if you can. If not, spread out paper on a smooth driveway (paper will keep vinyl clean) and work on a windless day. When you weld gores together, work on a home-made curved track, as shown at left; gores won't mate on a flat surface.

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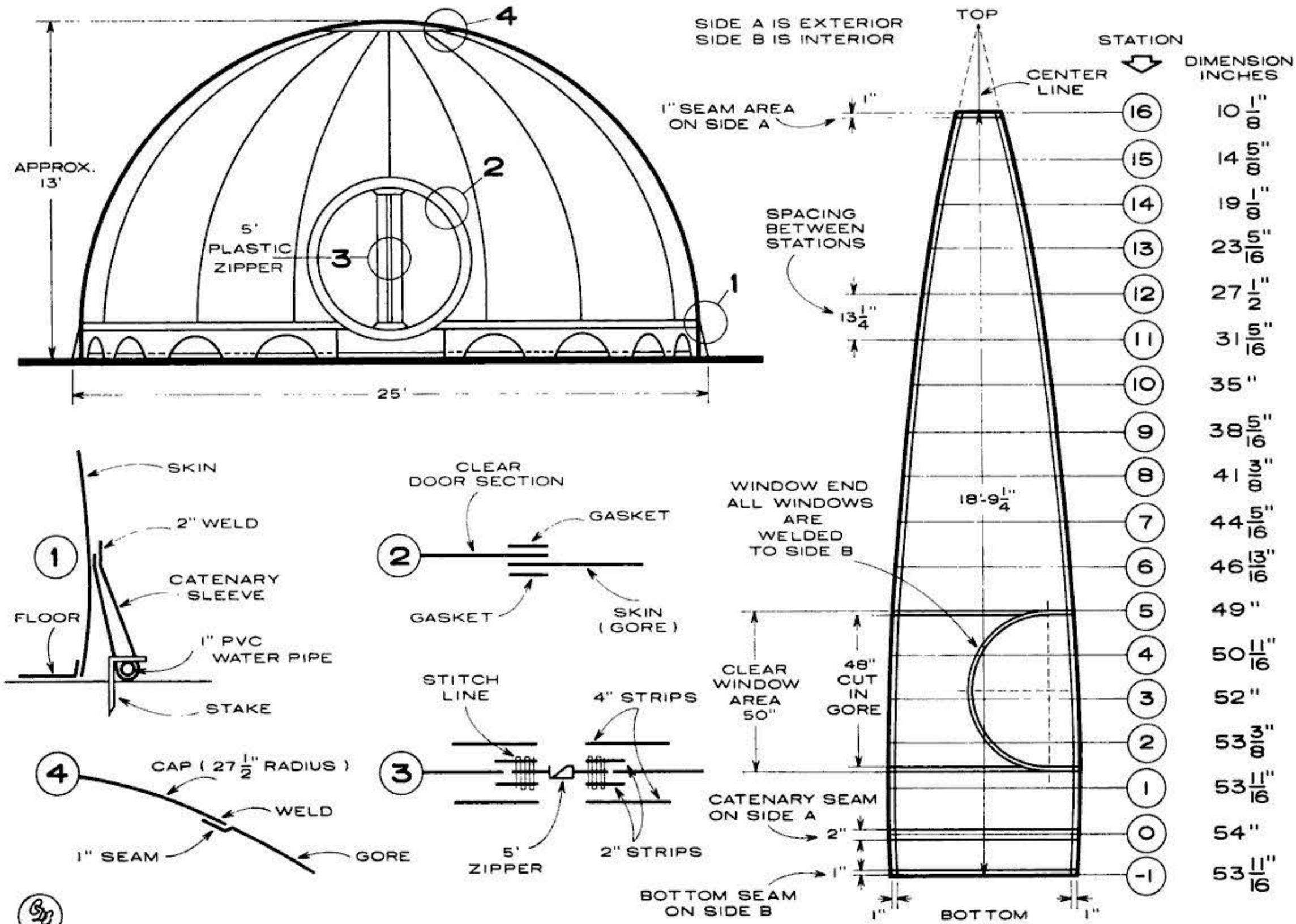

WELD DETAILS

GORE PATTERN

and collapse during heavy in-out traffic, the 25-foot prototype remains inflated even when the door is left open. The door in this case is a five-foot nylon zipper that opens and closes a slit-type entrance.

The blower. The air for all three structures is supplied by a Dayton direct-drive, squirrel-cage blower. Its ¼-hp motor has more than enough muscle to keep the dome pumped up.

How to order dome kits and plans booklets

Poor Willie's dome kits come complete with the necessary vinyl, full-size gore patterns, glue and solvent, blower, door zipper, and instruction booklet. Fabric floors are optional. Prices? 16-foot diameter dome kits—$300, $325 with floor; 25-foot dome kit—$415, $480 with floor; 34-footer—$565, $675 with floor. A plans booklet with gore pattern formulas, design ideas, materials sources is $5. Order from: Poor Willie Productions, 539 Tremont St., Boston, Mass. 02116.

Where wind loads are small, internal air pressure can be kept low. Two psf will do. Where wind loads are more severe, you increase internal pressure. Poor Willie calculates that 10 psf will support the dome in winds up to 80 mph.

Holding the dome down. The same air pressure that supports the dome would lift it off the ground if you didn't anchor it. Attached around the 80-foot perimeter of the prototype is a catenary sleeve of vinyl film, used to stake the dome down. Through this sleeve Poor Willie threads lengths of one-inch plastic pipe, joined to form a giant hoop. This can be staked to the ground, or fastened to a wood or plywood deck via plumber's strap and nails or screws.

Putting a dome together. Making a Poor Willie inflatable is pretty much a scissors-and-glue operation. A full-scale gore pattern guides the cutting of the 18 gores. Patterns in the plans booklet outline the window, door, and catenary pieces.

Once you have all parts cut out, prepare the gores for assembly. This involves cementing in window inserts, and outlining all the weld seams with masking tape. Next comes assembly of the door panel. This requires repeat passes with a sewing machine, but the rest of the assembly is the normal solvent-welding procedure. After the door panel is set, assemble the catenary sleeve, blower tube, floor, and cap parts.

Now you can weld together the two gores that will take the door assembly. All gores are welded on a curved track that's easily made from plans in the booklet. You can't weld the gores together on a flat surface—their edges won't meet.

After gores are joined cut out the circular hole for the door panel and cement it in place. Then cement the blower tube into its gore.

Once the door and blower-tube gores are done, weld together the remaining gores, taking care to keep the gore bottoms aligned. It's best to start all welds at the bottom and work toward the top. Don't stretch the fabric, or the windows and catenary's seam lines may not line up.

Main dome assembled? The catenary goes on next. It's followed by the floor—if you're using one. After you finish the final floor weld, let the dome sit for a few hours; better yet, overnight.

Next day you can lay the dome out, stake it down, and hook up the blower. In minutes you'll experience the unique feeling of standing inside your own bubble building. PS

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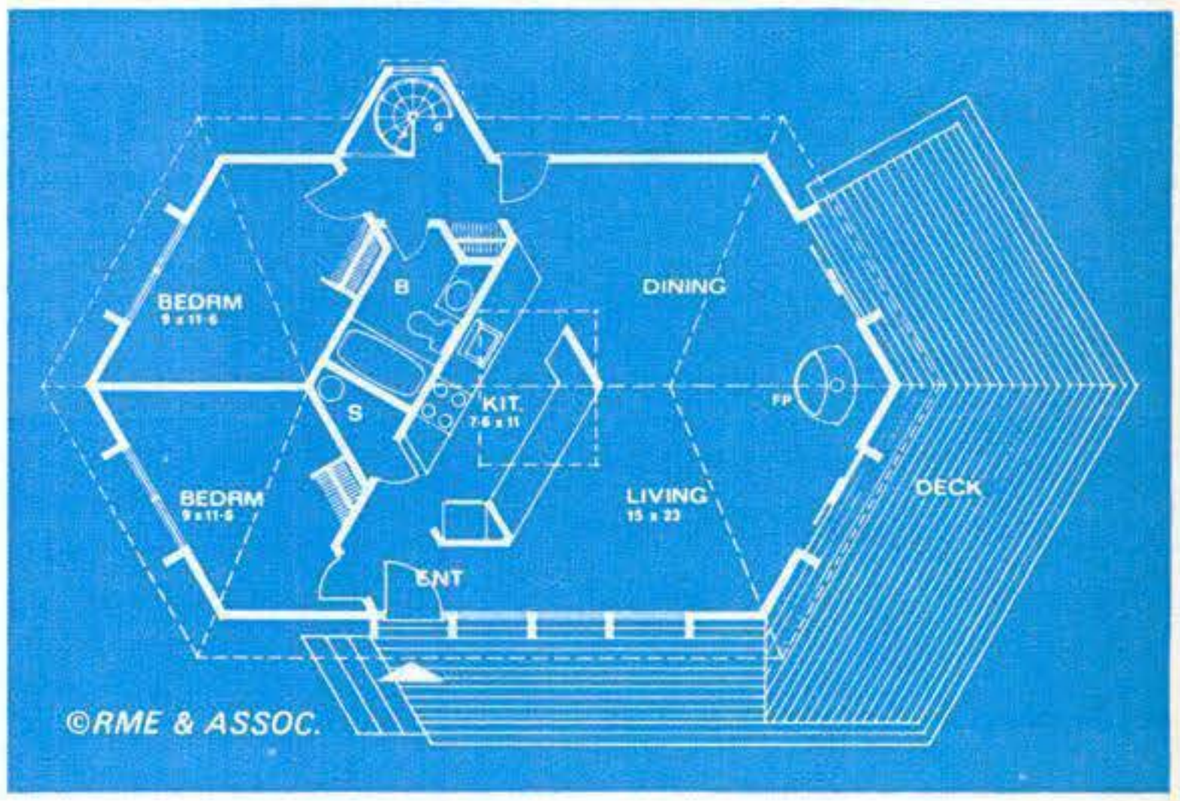
Stretched Hex Doubles Your View

Both ends of this open-plan house angle window-walls toward your scenery. Fifth in our V-PAC Council series



Novel in exterior shape and floor plan, this vacation house (one of architect Robert Martin Engelbrecht's Indian-named series for PS and the sponsors listed at right) is dubbed The Omaha. Tribal translation: "Those going against the current"—an apt description of adventurous builders who don't want a conventional house.

Two-thirds of the home's 800 sq. ft. is one large living-cooking-dining area, with insulating-glass sliding doors opening onto a spacious deck. The ceiling slopes upward to a central skylight. The kitchen is semi-concealed by wall fins that bracket the cabinetry. Of possible locations for the prefab fireplace, most dramatic is (as shown on plan) centered between the canted glass doors.

Though polygonal, each bedroom will accommodate a double bed—or bunks if preferred. A spiral staircase beside the back exit descends to the partial basement (full basement is one of many possible options).—*Al Lees*

Council members—and their specialties

American General (prefab stairs); Andersen (windows, gliding doors); Darworth Inc. (stains, preservatives); Du Pont (paints, interior finishes); Frigidaire (kitchen appliances); GAF (roofing); Georgia-Pacific (paneling, doors); Johns-Manville (insulation); F. E. Myers & Bro. (water pumps); Pass & Seymour (wiring devices); Simpson Timber (decking, siding); Singer (heating equipment); United Farm Agency (land resources); Universal-Rundle (bathroom fixtures); Heatilator (fireplaces).

You can order plans several ways

Omaha study plan ($1): floor plan with added specs to help you decide if it's for you. V-PAC Guide ($2): catalog of other plans in series. One set of blueprints: $25; three sets $35. PS Vacation Plans Service, Box 622, Princeton, N. J. 08540.

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YOU CAN TAKE IT WITH YOU

Bench Table Folds for Picnic

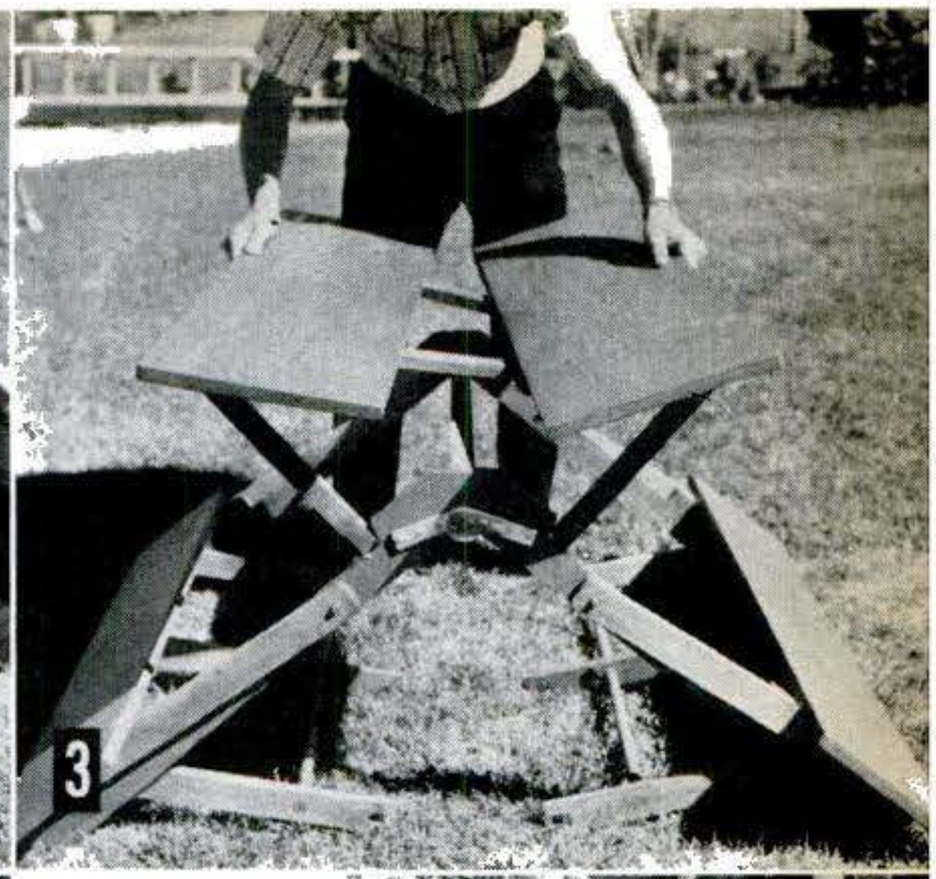
Easily-built collapsible unit lets you dine in comfort wherever you choose

By JOSEPH GIAMBALVO

You'll never fight for a roadside table again, once you've built this clever unit that flattens for toting in your trunk. Or, the unit has advantages for backyard use: When not needed, it folds and stores under cover, so when you want it, you'll find a clean, dry table—not a weathered mess. And since it isn't at the mercy of the elements all year, it'll last forever without refinishing.

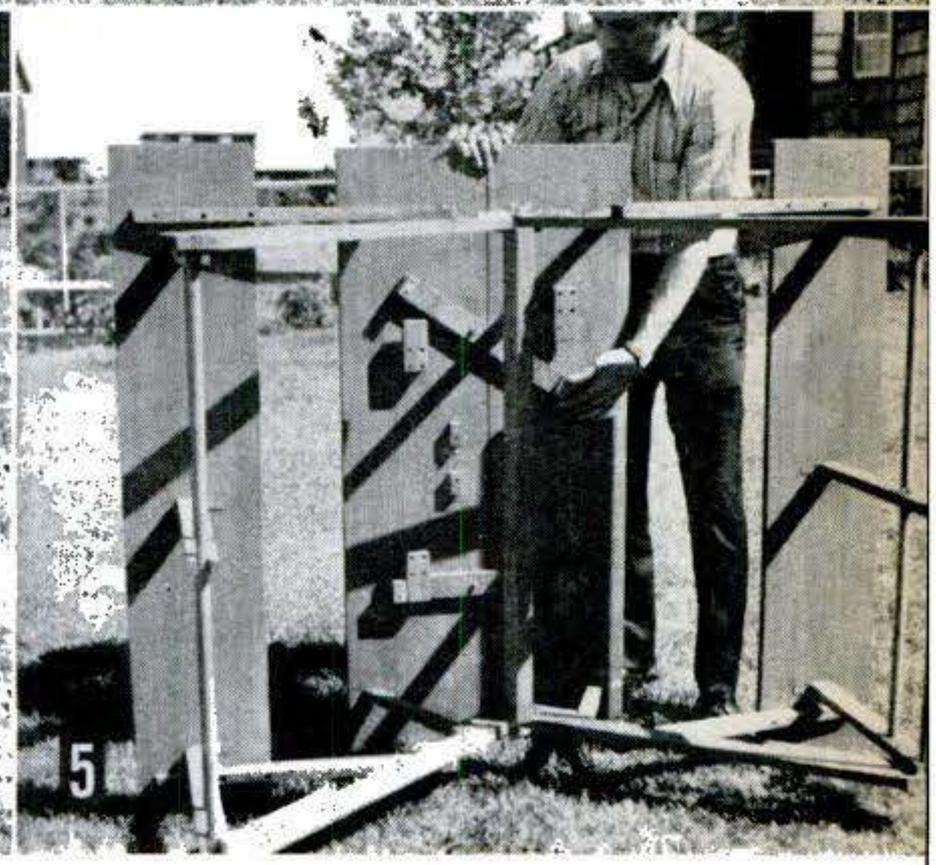
We even carry it along for boat-dock dining (below left).

Although my design is patented (No. 3,256,037) and can't be reproduced for sale, POPULAR SCIENCE



Setup is quick, easy, and needs no tools

Carry flat-folded unit to site, spread halves (1) and lock wingnuts on center beam. Raise table leaf that has tie bars and swing latter out about 45°; hook them over beam (2). Raise both leaves (3) so tie bars swing under opposite leaf; bring leaves together and swing tie bars into lock-blocks. Raise seats (4) and lower supports to notch over dowel. Set-up unit is sturdy enough to be tipped (5) to show tie-bar lock (not a set-up step).



Travel

readers are invited to build one table for personal use. Materials' cost should be under $30.

Construction is simple. Built of redwood and maple, the folding table is surprisingly sturdy when set up. The basic principle is triangular tension with three fixed points.

Hardware is standard, except for the pivot hinge. A long search for one to do the job proved fruitless, so I designed my own (sketch).

Ten of the backflap hinges are offset in a vise (next page) to permit a tighter fit when closed, and to allow the table leaf and seat to rest squarely on the supporting joint when open. The four hinges you *don't* offset go on the top (105-degree-bevel) end of the table supports.

Secure the hinges with No. 6 sheet metal screws—they give greater holding power than wood screws. In the maple, use a 52 drill for pilot holes (a sharp awl will do for softer redwood). When applying the hinges, take care to get a good fit on leg and table support, as shown.

Milled dimensions of 1-by-12 redwood are, of course, ¾″ by 11¼″. But the 1″ (¾″) maple was ripped into *actual* 2″ and 3″ widths from wider stock.

For accurate angles, lay them out with straight, dark lines. After cutting, true them on a disk-sander table, leaving a hair of the line. A

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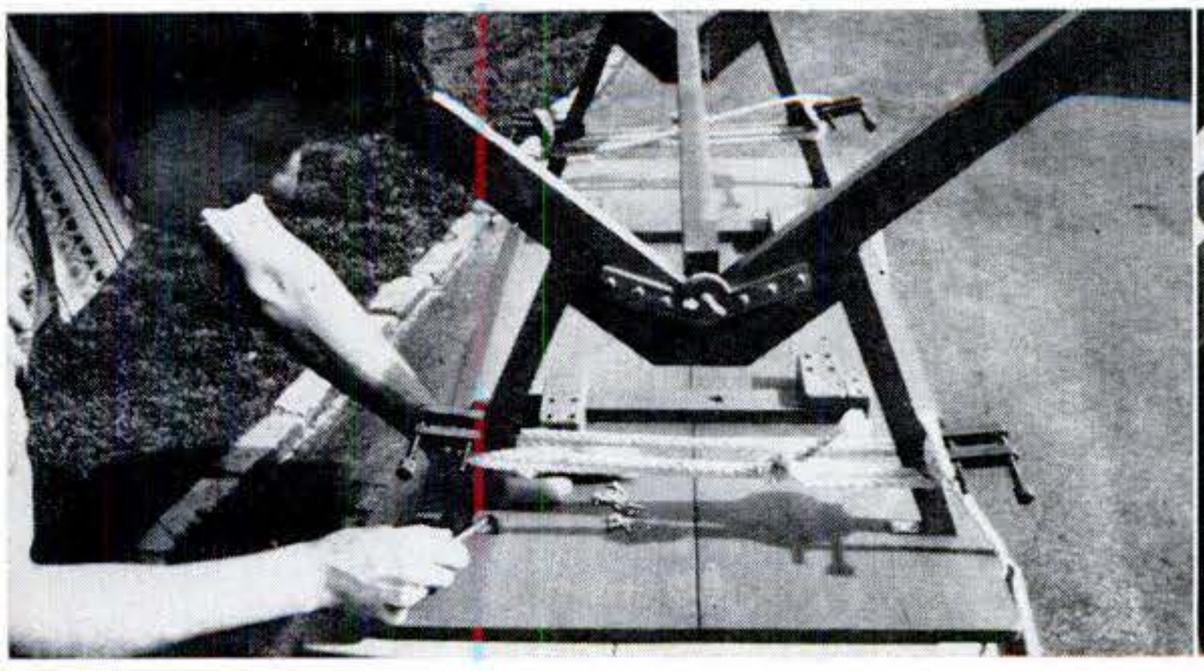
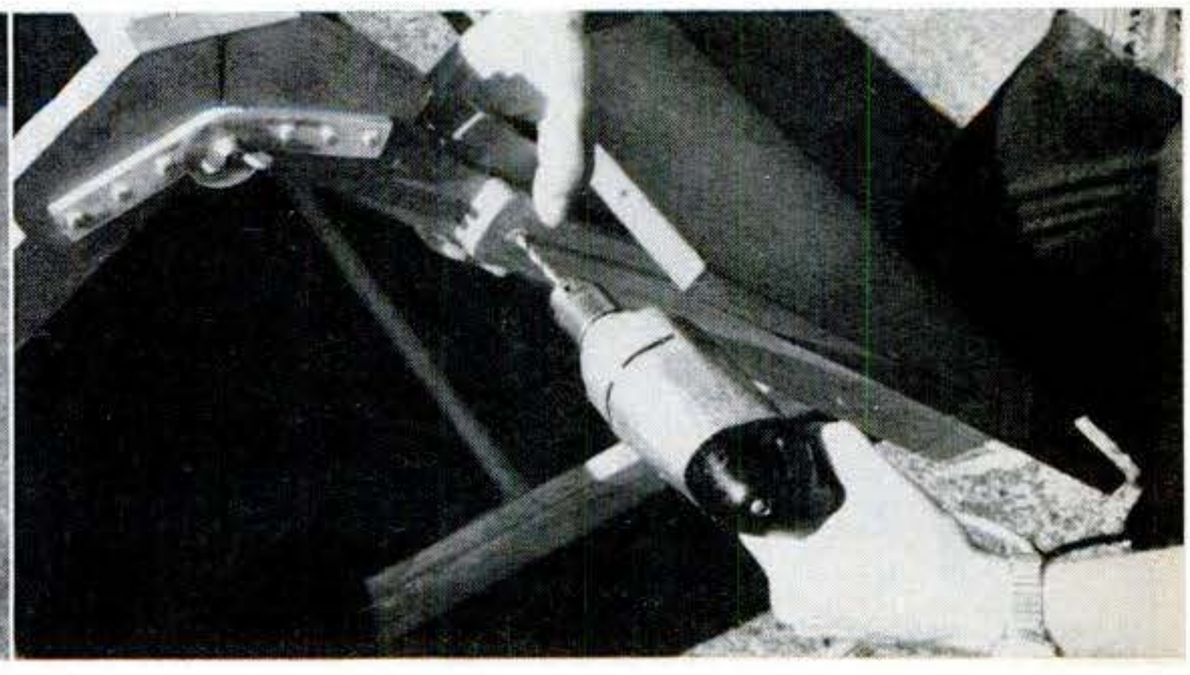


To fasten leg assembly to top, center on locked leaves, make starting holes with sharp awl, use offset screwdriver to turn hinge screws. Ropes hold position (clamps stop creep).



Once supports are fastened to seats, butt seat against table leaf, use predrilled 3/16″ hole as template to drill through leg for pivot bolts. Unit is semifolded as in photo 1, above.

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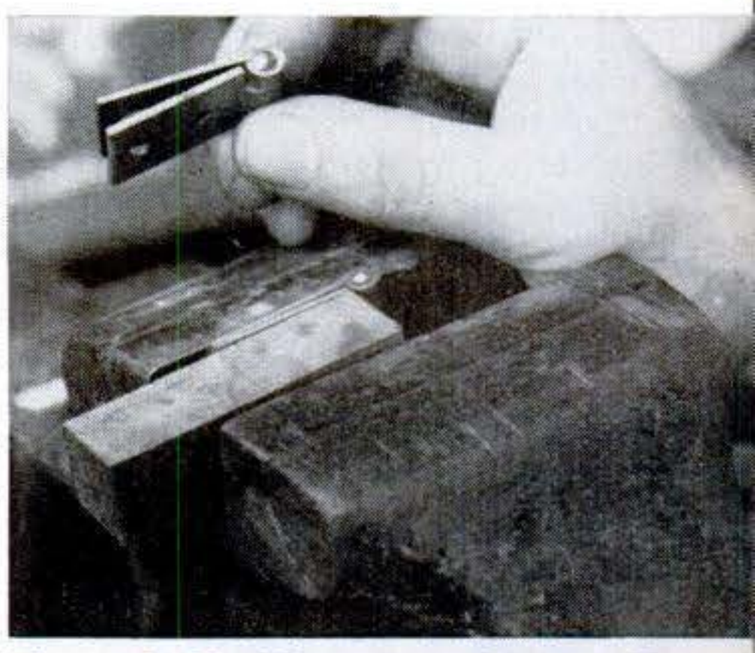
bandsaw is best for cutting the table supports out of the legs.

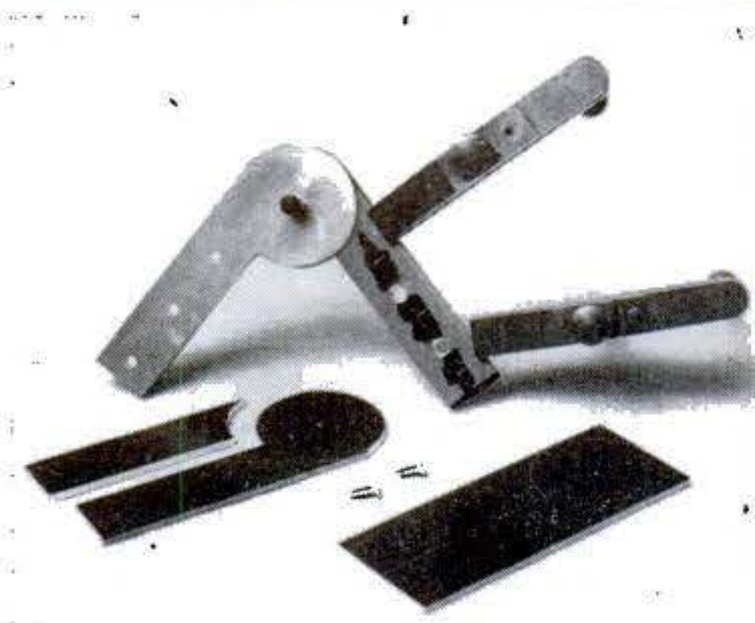
It's a no-waste project: Two of the four 4′ lengths of 1-by-12s are ripped to 9″ widths and the scraps are used for the tie-bar assemblies. From each strip, cut one tie bar and two spacers. For the cleats, glue and nail (from the bottom) the redwood spacer, paper spacers, and maple stop, *then* drill from the opposite side for the countersunk wood screws. The paper lets the tie bar slide under the cleat.

To pivot the bars to the underside, drill two 3/16″ holes through one leaf and countersink the top side so the flathead bolt sets below the surface. Relieve the opposite side so a nut can be locked flush with the surface (1″ of bolt protruding).

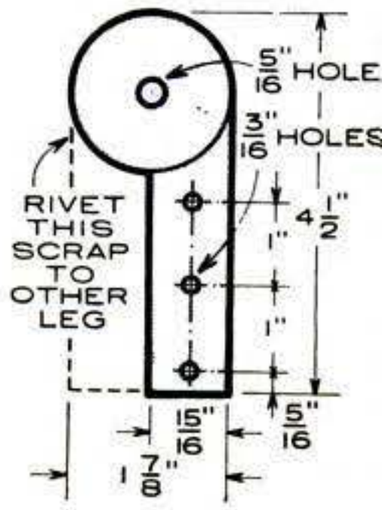
Attach the tie bar with washer and nut to pivot smoothly. Position it square with table edge, clamp a cleat to its stop, and screw in place. Sand a slight radius on one corner of the cleat so the tie bar clears yet locks snugly. PS

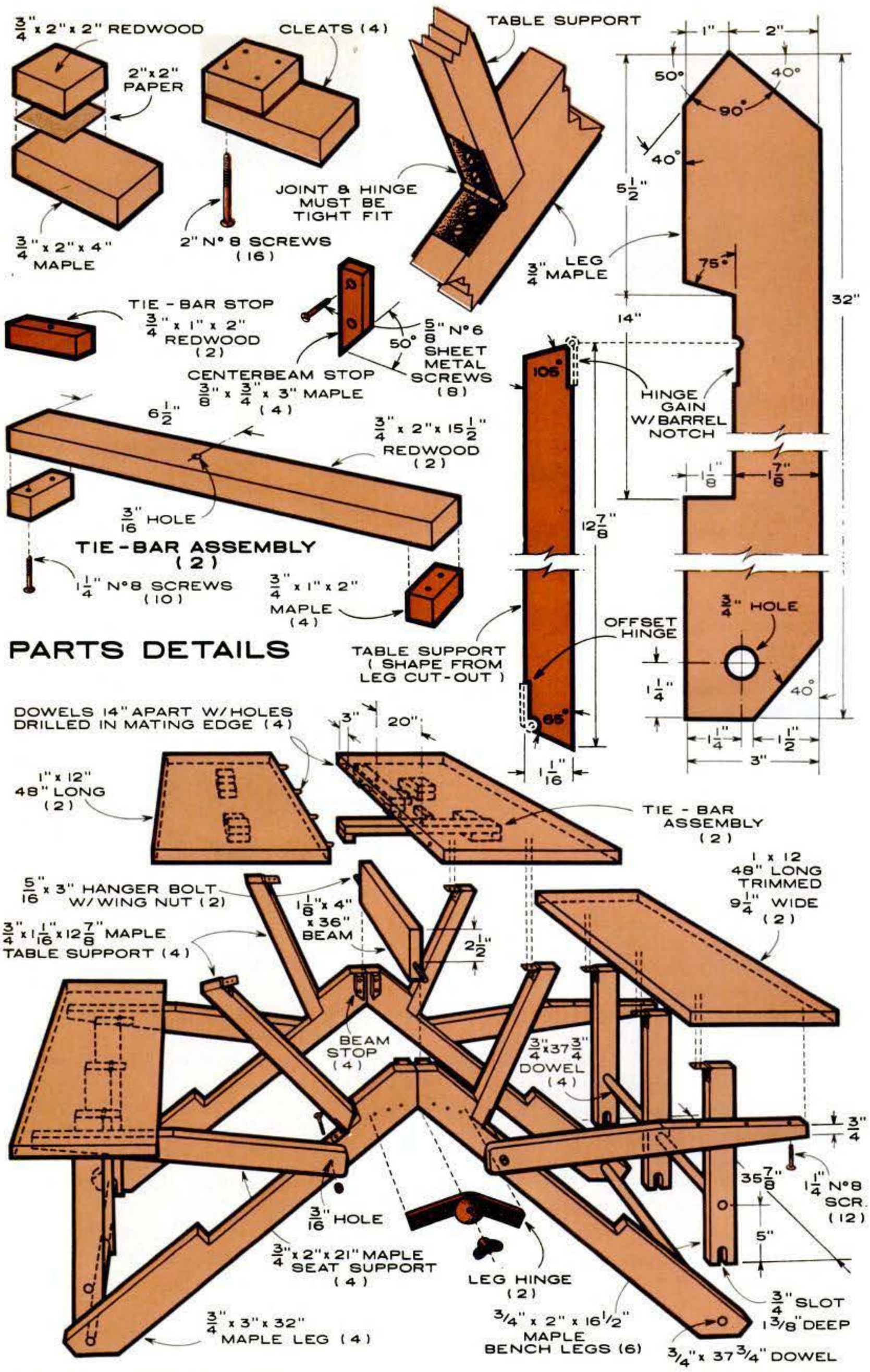


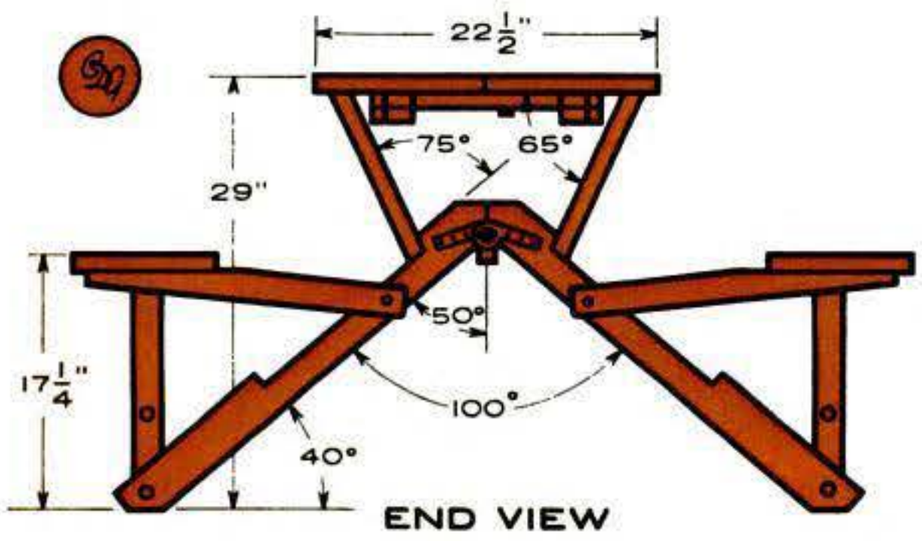
Ten of 14 hinges need reworking in vise. Place leaves against jaw, hold scrap steel against barrel, tighten vise to offset.



Make pivot of 1/8″ 2024 aluminum. Cut first side and clamp scrap to opposite leg; drill and rivet. Scrap acts as spacer. You'll need pair for each end. Center-beam bolt is pivot.







MATERIALS LIST

Amt.	Lumber
1-x-12, 16′	redwood
1-x-3″, 11′	maple
1-x-2″, 15′	maple
1 1/8″-x-4″, 3′	pine
1 1/8″-x-4″, 3′	pine
3/4″-x-36″ (2)	hardwood dowels
3/4″-x-38″ (2)	hardwood dowels

Amt.	Hardware
14	3/4″ backflap hinges
2	5/16″-x-3″ hanger bolts
2	5/16″-18 wingnuts
6	#10-24-2″ FH stove bolts
12	nuts to match above
12	#10-x-3/4″ pan-head sheet-metal screws
20	#8 1 1/4″ FH wood screws
16	#8 2″ FH wood screws
64	#6 5/8″ FH sheet-metal screws
4	1/8″-x-2″-x-4 1/2″ 2024 aluminum
2	friction catches for legs

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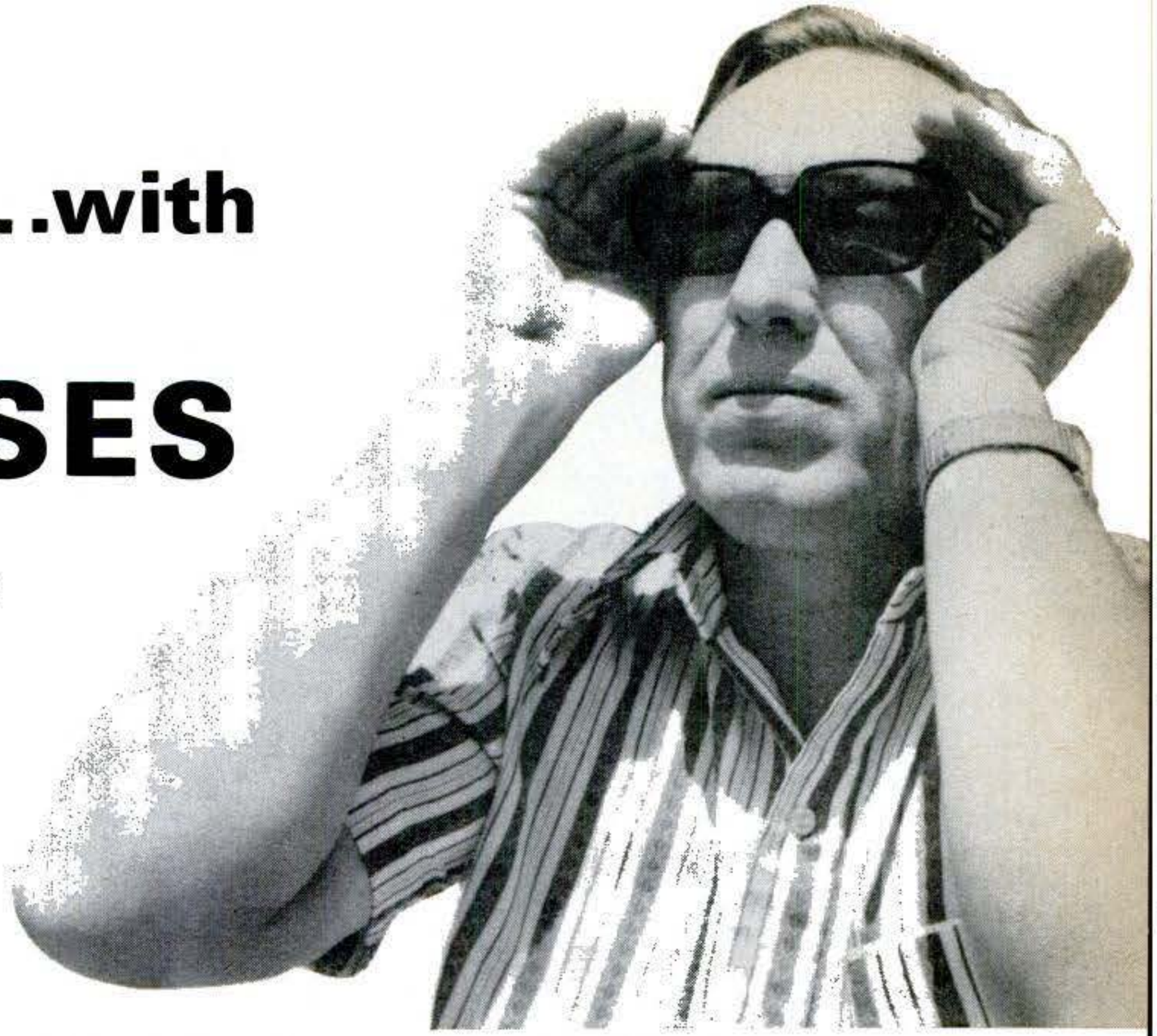
Beat the Squint...with the Right

SUN GLASSES

Color? Light transmission? Here's what to look for in sunglasses—and why you need a pair that'll do the job

By RICHARD DAY

This article has been reviewed for accuracy by the American Optometric and American Medical Associations.



Lens coverage is stingy if cupping (above) gives more eye comfort.

If you buy sunglasses for style and a cheap price, join the club. Not one of us would choose our eyeglasses that way, but sunglasses . . . well, they're different. Or are they?

Exposure to visible and invisible light rays for long periods can make your eyes sting and burn. And you don't need a doctor to tell you that long periods in an especially bright environment—the beach, on the water, in snow, or on the highway on a bright day—can result in considerable physical discomfort, and possibly even danger if you're driving into the sun at 75 mph. Also, excessive exposure has been known to cause cataracts—an opacity of the lenses of the eyes—which, if not surgically removed, bring on eventual blindness.

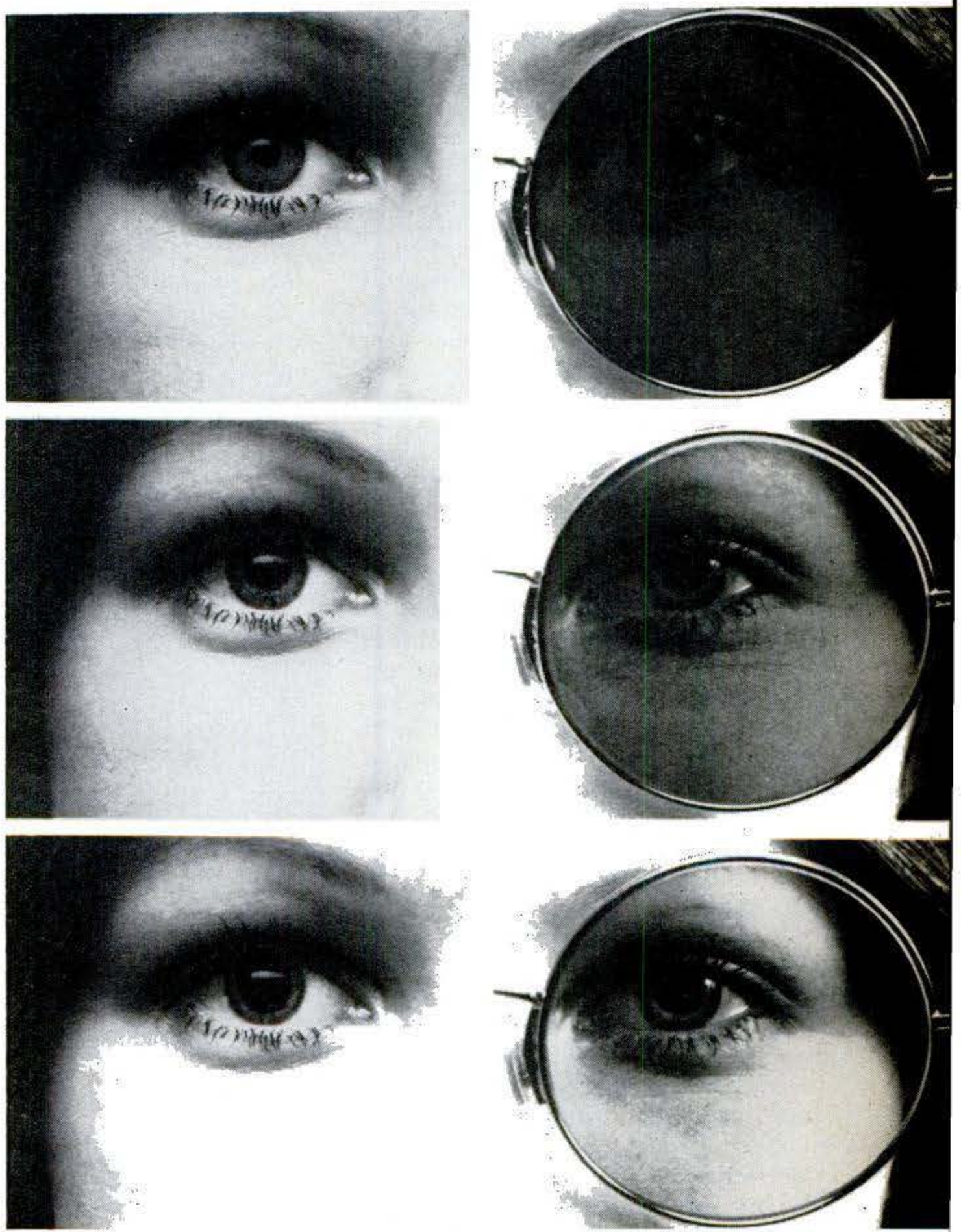
At any rate, anyone who goes outside on a bright day needs sunglasses. So do some who work in brightly lighted interiors.

A day spent outdoors in bright sunlight may rob you of as much as 50 percent of your ability to see at night. It may take as long as a week without further exposure to recover your normal night vision. The worst is that you don't even know; you have no basis of comparison. Compared to this, the permanent squint lines that glare puts on your face are a relatively minor problem.

Most people recognize their need for sunglasses. As a result, the annual dark-specs market stands at $300 million, largest in the whole beauty/health-care field. But sunglasses come in a tremendous variety of styles, colors, and shapes, with plastic or glass lenses, and selling from 50 cents up to $50 or more. Here's what you need to know to pick the best ones for you.

The lens. Obviously, the most important part of sunglasses are the lenses. The best lenses are optically ground and polished either *in plano* (noncorrecting) or to prescription. Sunglasses with these ophthalmic-quality lenses cost $10 and more. Cheaper lenses are stamped and heat-formed or injection-molded of colored plastic, or are blown from glass. Some of the plastic ones

Continued



With diminishing light (top to bottom), the photochromic lens at right gets clearer, while the pupil in uncovered eye enlarges.

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Flier's glasses by Bausch and Lomb have gradient-density lenses. Clear section at bottom enables him to read instruments, while his eyes are protected.

are specially treated to be polarizing, thus filtering out horizontally polarized reflected light from road, water, etc., while passing vertically polarized information-carrying light to your eyes. Formed, molded, and blown lenses vary from good to terrible, but they're never of ophthalmic quality.

However, it's by no means clear that you need this expensive quality. Dr. Arthur H. Kenney, chief ophthalmologist of the Wills Eye Hospital and Research Institute, Philadelphia, says, "The eye cannot be damaged by warped and irregular glasses any more than one can harm his eyes by looking through a cheap windowpane or into an irregular reflecting mirror in an amusement park. Visual disturbances from such wavy surfaces may be unpleasant or frankly nauseating, but do not damage the eye."

Test your own sunglasses. If you have a slide projector, project a slide through them. This shows up lens aberrations graphically and immediately. A rating of excellent indicates ground-and-polished lenses of ophthalmic quality, the kind your eye doctor would recommend. No others, I found, could produce a truly sharp image on the screen.

A sunglass lens, to be effective, should pass no more than 30 percent of the light that falls on it. For outdoor use, a 15-20-percent range is better. (Sadly, the manufacturers rarely give you their transmission figures.) Naturally, the two lenses should be matched in their color and density.

Lens colors vary all over the rainbow, but for reliable color perception, neutral gray performs best, especially for driving. Odd colors can distort your color perception. (*That* may not bother you, but you should be sure they're dark enough.) One shade of green lens, though, matches the color sensitivity of the human eye, and thus can pass as much as 30 percent of the light and still provide the same glare protection as a darker neutral-gray lens. If you need accurate color perception, however, stick to gray.

Polarizing lenses, because they reduce polarized reflections and darken polarized sky light, may pass more light than nonpolarizing lenses. Their optimum transmission is 20 to 25 percent. These lenses comprise half the market today.

Sunglass lenses with one-way mirror-like coatings hold back some of the light without affecting color perception. But watch it. One cheap pair I bought reflected so much light from behind the lens that glare was always a problem, even indoors.

Gradient density. On some of the best Bausch & Lomb lenses a heavy-density shiny Inconel coating may be vacuum-applied at the top, but not at lens center or at bottom. Or it may be used low on colored lenses to reduce ground glare. These gradient-density lenses are especially useful to pilots and truck drivers who must shift their eyes from the bright road or sky to the darker instrument panels they monitor. While indispensable to them, such lenses may prove distracting to others.

All sunglasses, if the lenses are dark enough, filter out enough of the visible light spectrum. But what about ultraviolet and infrared rays? Most reputable sunglasses handle both all right. Plastic lenses permit more infrared rays to reach the eye than glass lenses do. But it may not matter. Julian Morris, information officer of the National Eye Institute, says the ability of sunglasses to screen either ultraviolet or infrared is unimportant. There's not enough of those rays in the natural environment to harm the eyes.

Test for impact resistance must be passed. Lens must not shatter when steel ball (above) drops 50 inches onto it.

Impact resistance. More than a year ago, the federal Food and Drug Administration set a minimum impact resistance for lenses in practically all glasses, including sunglasses. Even imports sold here must meet this requirement for your eye protection. Glasses manufactured before 1972 and not yet sold are still legal, however, so it's a good idea to look for a label stating that the glasses meet the current impact-resistance minimum. Glass lenses must be heat-treated, chemically tempered, or hardened to render them impact resistant enough to stay whole when the FDA-required 5/8-inch steel ball drops 50 inches onto one. Meeting the federal standards does *not* mean the specs rival safety glasses.

About frames. You will find both plastic and metal sunglass frames in many styles and qualities. Some poor lenses may even come in great frames. The better plastic frames give you widened nose rests. They also provide metal cores inside plastic temples to prevent breakage and to permit bending for fit. While you cannot see the wires in opaque frames, if the same manufacturer's see-through styles have them, the wires are usually there.

A brow band to reinforce the bridge on wire frames shows increasing popularity. On some sunglasses it wears a plastic-covering for cushioning. Rocking nose pads of plastic are found on most wire frames.

When you buy your next pair of sunglasses, you'll run into what are called "funglasses"—the ones with the zany shapes and colors. Most are made for women, though you'll find them in men's styles, too. Get them for fun, if you like, never for glare protection. Their lenses aren't dark enough.

If you choose sunglasses for children, see that they meet the same optical and safety standards you'd want your own to have. Most of those sold in the bargain bins as "children's sunglasses" meet no standard but low price.

Contact lenses in suntint are available, but any constant changing between them and regular contacts can be a hassle. Regular sunglasses used with contacts are a better bet.

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Sunglasses: A PS buyer's guide to some popular models

MANUFACTURER	MODEL	LENS MATL.	COLOR & TRANSM.	PROJ. TEST & COVG.*	FRAME DESIGN	NOSE-WGT. (gm.)	AUTHOR'S COMMENTS	PRICE
Bausch & Lomb 635 St. Paul St. Rochester, N.Y. 14602 (Ray-Ban brand)	Outdoorsman	Glass	Gray 4%-19%	Exc. Exc.	Gold wire, plastic-covered brow bar, hooked temples	35	For active outdoor sports and work. Hooked temples keep them on. Top gradient-density lenses darken sky without distraction.	$23
	Caravan	Glass	Gray 4%-19%	Exc. Exc.	Gold wire, rocking nose pads, plastic-coated temples	35	Very comfortable. Double gradient-density lenses (optional) are tops for driving, boating. Plain or top gradient-density lenses better outdoors.	$20 to $24
	Bainbridge	Glass	Gray 19%	Exc. Good	Substantial yellow-gold frame, as above	45	New, distinctive shape. Comfortable and effective. Fine outdoor glasses.	$21
	Metal sunglasses	Glass	Gray 19%	Exc. Poor	Black wire, as above. Others available	45	Design became famous in World War II as aviator sunglasses. Constant awareness of the lenses.	$20
	Arnold Palmer Cypress Point	Glass	Gray 19%	Exc. V. Gd.	Plastic see-through shell design, wire-core temples	50	In spite of weight, comfortable glasses for all-round use. Wide 9/16" temples are illegal for driving in some states.	$14
	Monti	Glass	Gray 19%	Exc. Fair	Metallic brown plastic with wire-core temples	45	Comfortable, masculine shades at low price, considering quality. Not enough side coverage for those with wide vision.	$12
	Blair	Glass	Gray 19%	Exc. V. Gd.	Ebony plastic with wire-core temples	57	A large glass especially suited to big men. Temples 5/8" may be illegal for driving.	$15
	Ski Goggles	Plastic	Gray 20%	Poor Exc.	Ventilated plastic frame, elastic headband, sponge-rubber face frame	—	Neat for skiing, and other outdoor activity. No light leakage around sides. One size goes on over prescription glasses.	$15
Opal-Lite, Box 3097 South El Monte, Ca. 91733	Passport 601GT	Plastic CR-39	Gray 30%	Exc. V. Gd.	Plastic frame, metal brow band, aluminum temples	27	Light comfort in an ophthalmic-quality sunglass, thanks to ground-and-polished plastic lenses. Would choose darker lenses.	$18
Cool-Ray Cool-Ray Park Boston, Ma. 02150 (Cool-Ray Polaroid brand)	No. 420 Fast Back	Plastic polariz.	Gray 20%	Fair Exc.	Bronze-anodized aluminum, plastic insert nose rest	18	Because of light weight, most wearable sunglasses tested. Easy to forget you have them on. Modern styling.	$ 8.95
	No. 300 Roadmaster	Plastic polariz.	Gray 20%	Fair Exc.	See-through plastic in demi-amber	20	Excellent for those with wide peripheral vision because of wrap-around lens design.	$ 7.50
	No. 275 Jet Age	Plastic polariz.	Gold 24%	Good Good	Gold wire, brow bar, rocking nose pads, ear protectors	20	Nice-appearing and comfortable.	$ 7.50
	No. 186 Open Road	Plastic polariz.	Gray 20%	Good V. Gd.	Chromed plastic, metal temples	20	Gives a rugged metal-frame appearance without weight of metal.	$ 5.50
	No. 76 Apollo Eleven	Plastic polariz.	Blue 30%	Good Fair	Silver wire, brow bar, rocking nose pads, temple ext.	15	So light you barely notice them, yet they have large, comfortable spatula temples.	$ 7
	No. 205 Sports Rally	Plastic polariz.	Gold 28%	Good Exc.	See-through amber plastic	18	Well-curved frame for fine side coverage. Frames look unfinished.	$ 6.50
	No. 230 San Andro	Plastic polariz.	Gray 15%	Fair Exc.	See-through amber plastic	21	The darker lenses may be a production variation, but they make this glass extra good for beach or snow wear.	$ 6.50
	No. 149 Sun Tack	Plastic polariz.	Gray 27%	Fair Good	Black plastic	20	Lenses are of unusual shape.	$ 4.25
Tropic-Cal 1330 South Los Angeles St. Los Angeles, Ca. 90015	No. 151355	Glass	Bronze 30%	Fair Good	Gold wire with brow bar, plastic temples	43	New aviator style with black accent stripes that belie the price. Lenses seem darker than they are.	$ 6
Rayex Corp. 133-30 37th Ave. Flushing, N.Y. 11354	Reg-u-Lite Photo Chromatic	Plastic	Green 26%-30%	Fair Exc.	See-through amber plastic	27	Lens changes color when exposed to sunlight, changes back again indoors. Light transmission increases in sunlight.	$ 4
	Reg-u-Lite Photo Chromatic	Plastic	Green 22%-25%	V. Gd. Fair	Gold wire, brow bar, rocking nose pads, plastic ear tips	21	Lighter, but not as full coverage or as comfortable as above. Lenses change color, as above.	$ 5
American Optical Corp. Southbridge, Ma. 01550 (Sunvogues brand)	Photosun Fastback	Glass photo-chromic	Tinge to gray 65%-20%	Exc. Good	See-through plastic with wire-core temples	42	The very latest development. Uses Corning Glass Sun-sensor dark lenses. Prescription pair should be very useful, too.	$24.50
Renauld International Ltd. 350 Fifth Ave. New York, N.Y. 10001	React-A-Matic Sportsman Style 2501	Glass photo-chromic	Tinge to gray 65%-20%	Exc. Good	Plastic frame, metal brow band, aluminum temples	44	Photochromic same as above. This brand is widely available in department stores.	$25

*COVG. — Extent of eye coverage by lens.

While clip-on sunglasses offer you glare protection if you must wear eyeglasses for driving, they can be a nuisance. All those glass surfaces reflect light, and the double pairs are heavy on your nose. Preferably, get a pair of prescription sunglasses. You can get them with either glass or plastic lenses. Plastic is lighter in weight, but can be touchier to keep clean without scratching.

Now, darker photochromics. The newest sunglasses change to fit the surroundings like chameleons. Mildly gray-tinged indoors, they darken amply within minutes after you step out into the sunshine. And while the sun shines brightest, they display their deepest tone. In the shade they fade more slowly to lighter tints. Go indoors and they lighten still more, going back to their initial gray tinge. The smooth dark/fade action is called photochromism.

It never wears out, according to the Corning Glass Works, whose scientists created the first photochromic glass back in 1964. Now, a variety that's dark enough for successful sunglasses is out.

The process works much like exposing photographic film in a camera. Silver halide microcrystals, each so small that a cubic centimeter of glass contains some five quadrillion, turn dark when exposed to ultraviolet radiation. Wave lengths in the 300 to 400 millimicron spectral range do the business; those below that range are absorbed.

Unlike the photographic process, photochromic's silver halides are not developed or fixed, nor are their residues washed away. Thus photochromic glass returns to its lighter form soon after the ultraviolet radiation has gone.

The new, successful photochromics come the closest to automatic sunglasses yet. Currently, all makers of prescription sunglasses in North America offer them. The feature adds about $15 to cost.

I recently wore a pair of the new plano photochromic sunglasses for a week. I used them for hiking, driv-

[Continued on page 135]

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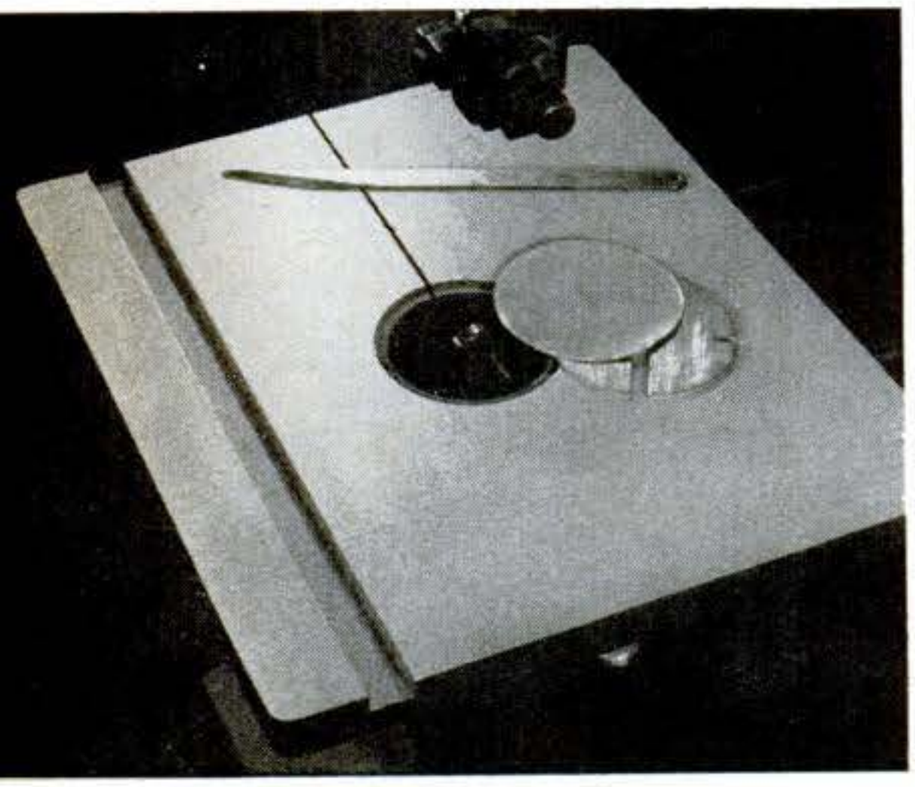
SLIP OR STICK Which do you want things to do? On the next four pages, PS introduces a new product for each job

Easy-Apply Teflon Film Puts the Skids on Home and Shop

A special arrangement with the maker puts this friction-fighting surface in the home-owner's hands for the first time

By R. J. DeCRISTOFORO

Back in December '67 we told you about Du Pont's Teflon-S and its advantages when used on power-saw blades and other shop and garden equipment. Later [PS, Aug. '71], we brought you the news about Xylan, a spray-on product you could apply yourself with a minimum of fuss.



Glass-backed Teflon film does a fine job of reducing friction between work and work table. On this bandsaw, author covered table, insert, miter-gauge groove.

Now, exclusively for POPULAR SCIENCE readers, there's news about a new self-adhesive Teflon film that you peel from a backup sheet and apply just about anywhere. It's ready to use the second you put it on.

We tested it in and out of the shop and home, and can report impressive results wherever a slippery, antistick surface is an advantage over, for example, untreated steel or wood. The new product also has exceptional chemical resistance and zero moisture absorption.

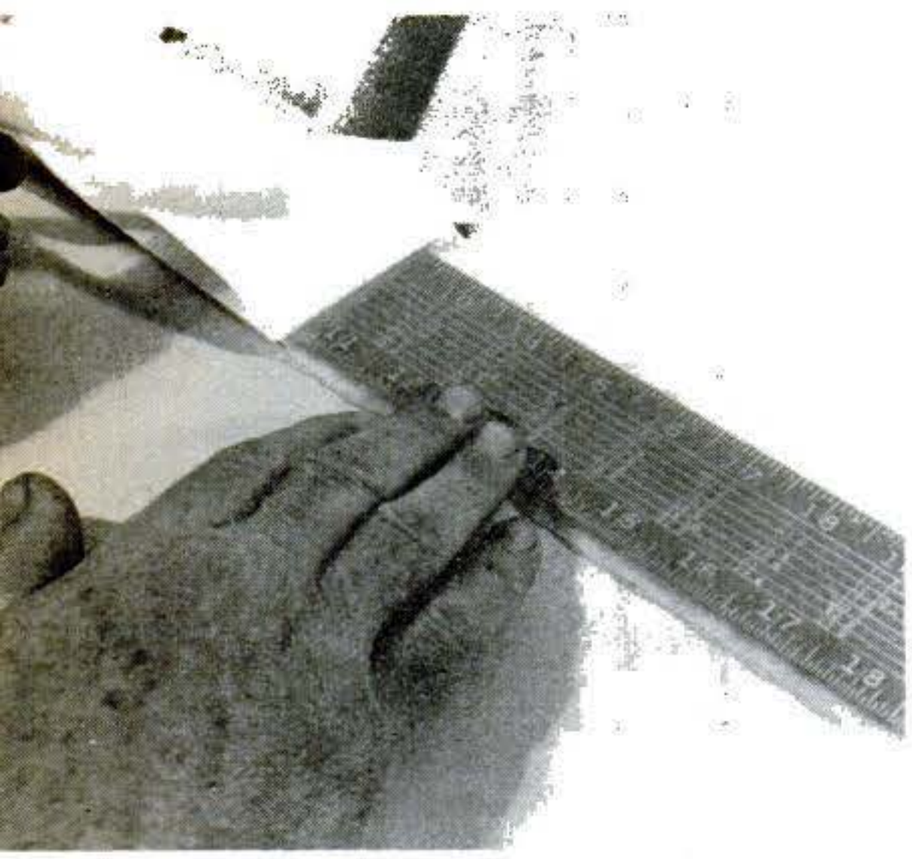
These characteristics, plus ease of application, make it ideal for, literally, hundreds of "sticky" situations we live with every day—in the shop, studio, lab, kitchen, darkroom, etc.

What is the stuff? This new film isn't available through stores or other normal consumer channels. But through special arrangement with the manufacturer, PS is making it available to its readers. You'll have a choice of two types—one is a self-adhesive, unsupported Teflon film (.005 in.); the other, a pressure-sensitive Teflon/fiberglass version that is .007 in. thick. Each will be mounted on a peel-off, protective paper backing. The adhesive used on both products provides high bond strength and has good aging characteristics.

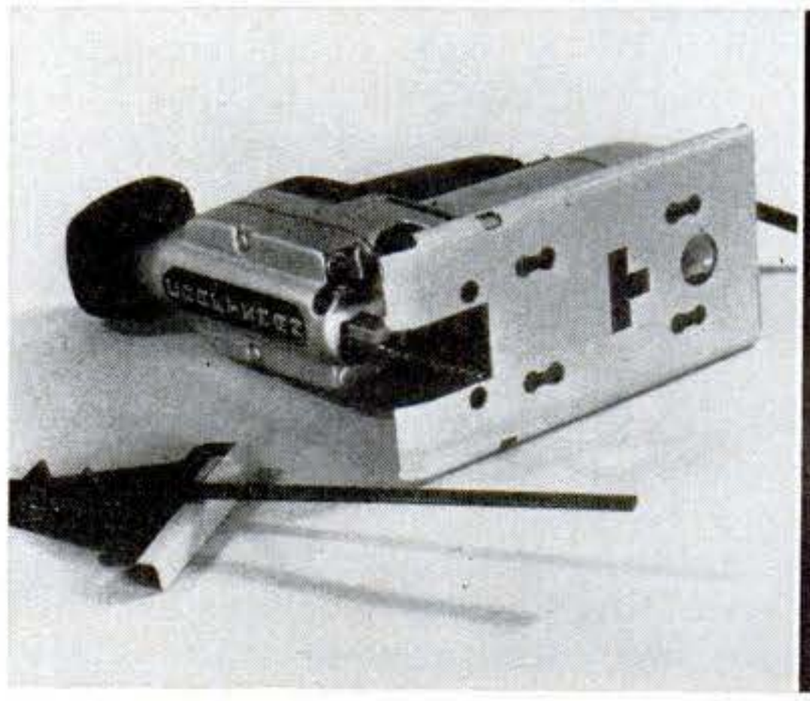
To distinguish between the two, in general terms, we would have to say that the fiberglass type falls in heavy-duty application areas. It is tougher than the unsupported film. On the other hand, the latter will conform more readily to irregular surfaces and it affords a see-through factor that can be an advantage in many areas. For example—on a carpenter's square or the stop rods on a drill press.

Some tricks I tried I covered one side of a 19-lb. steel bench weight (kept on hand for various hold-down jobs) with Teflon film and placed it on a length of ¾-in. plywood. The weight slid easily when the board was tilted to about 15 degrees. When the weight was placed so that the untreated side was in contact with the wood, the board had to be tilted about twice as much before the steel would slide.

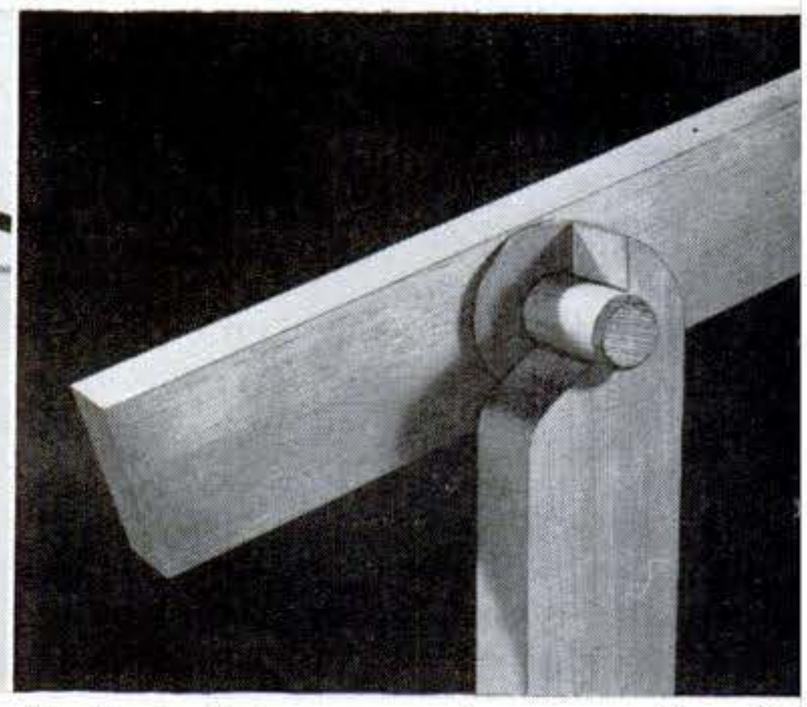
After applying a piece of the film



Unbacked film is transparent so you can stick it on a square and still read the scales. Here the material can earn its keep by preventing rust, discoloration.



The reinforced film, used on the plates of portable power tools like this saber saw, will give you pleasing results. Try it on routers and cutoff saws, too.



Swivel joints—wood or metal—will really swivel when you coat contact areas with Teflon. Here a washer is covered on both sides. Option: cover mating faces.

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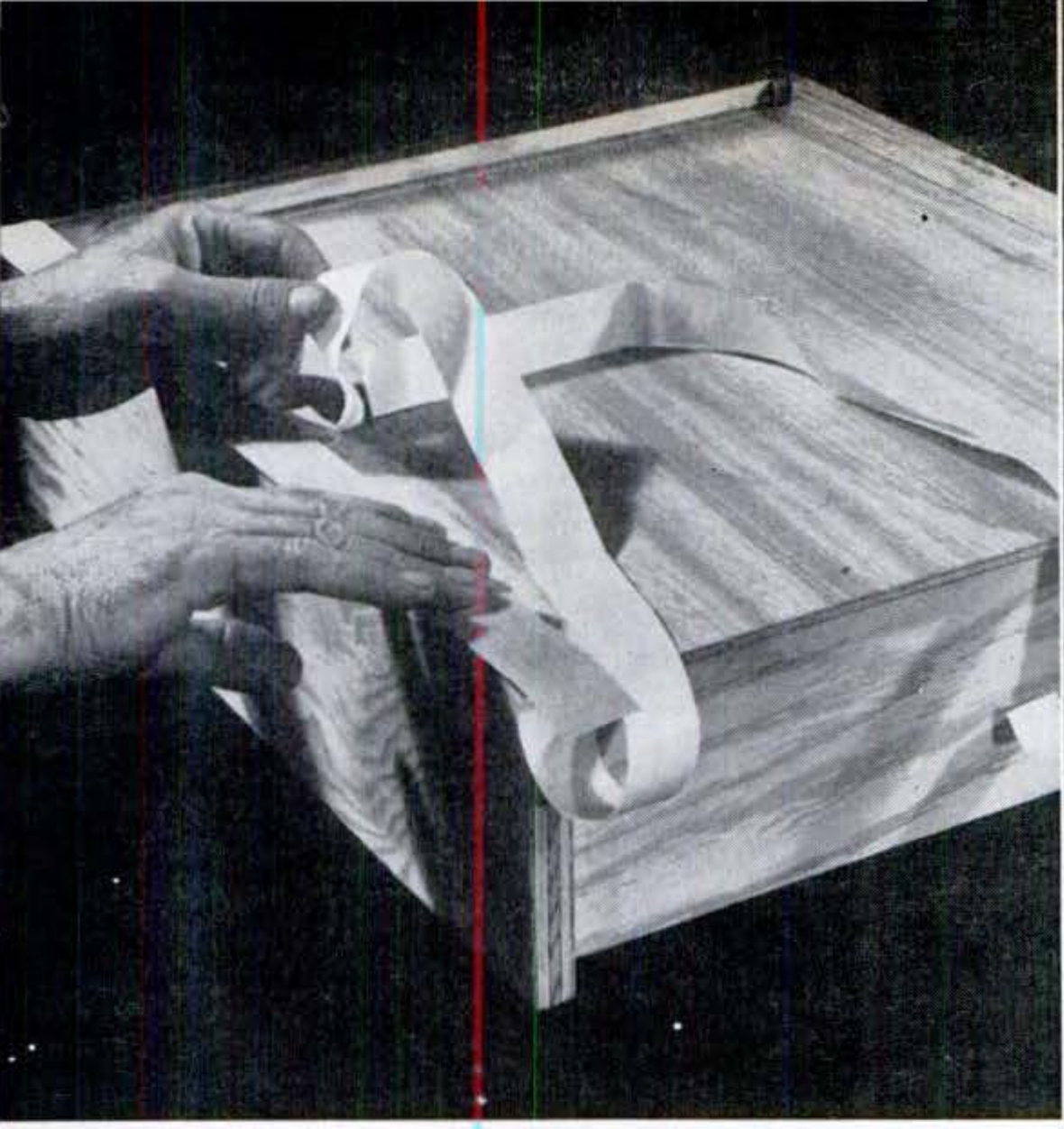
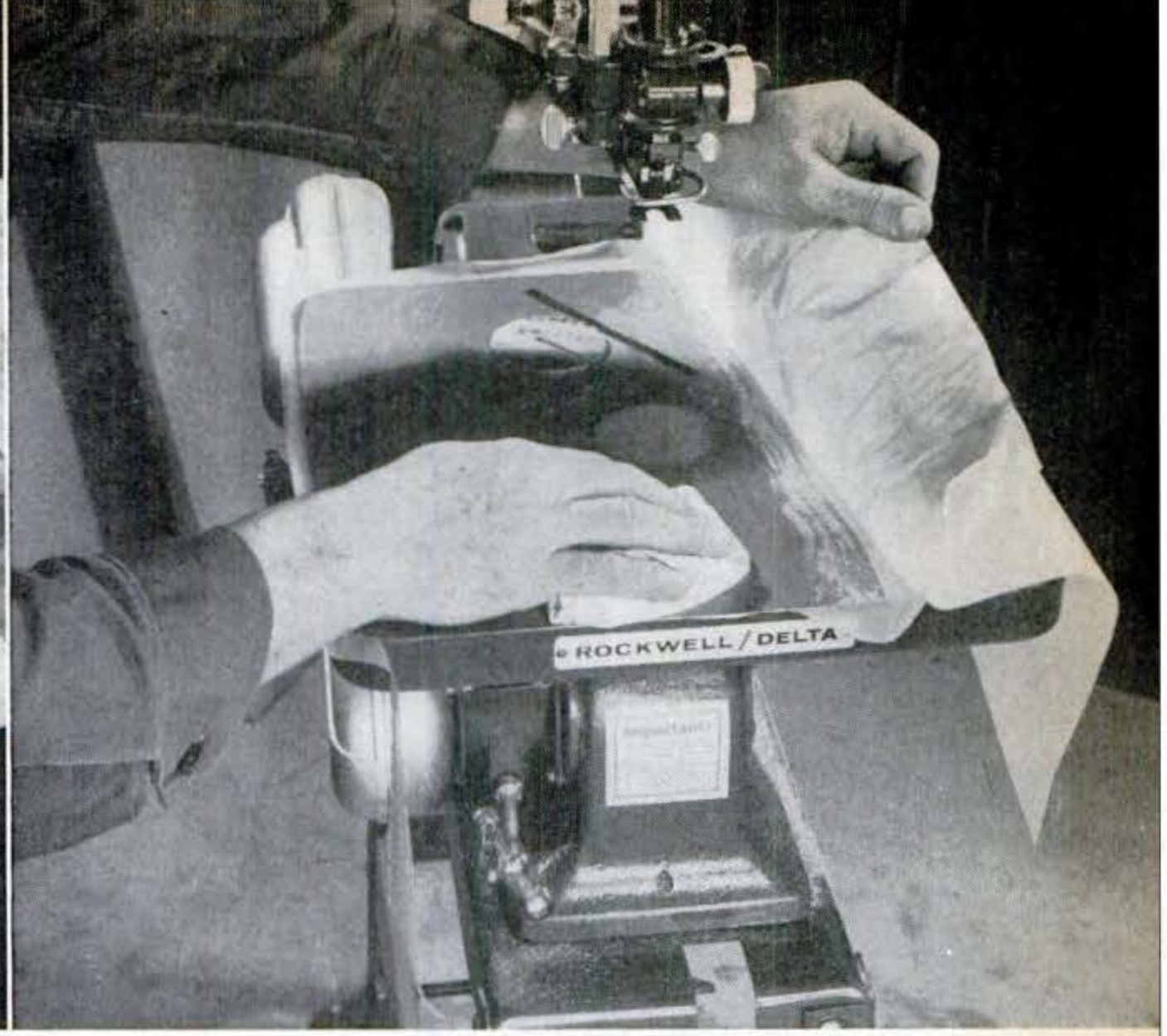


Sticking drawers are a thing of the past when you cover sliding areas with strips of glass-backed Teflon. The skiving operation shown below isn't needed here, but do make sure to rub down all edges very firmly for good adhesive contact.



Unmounted film held up fine on author's jigsaw table. This version of the slippery film is more flexible than the backed type, and so more likely to capture air bubbles. Apply it to a small area at a time as you peel off the backing.

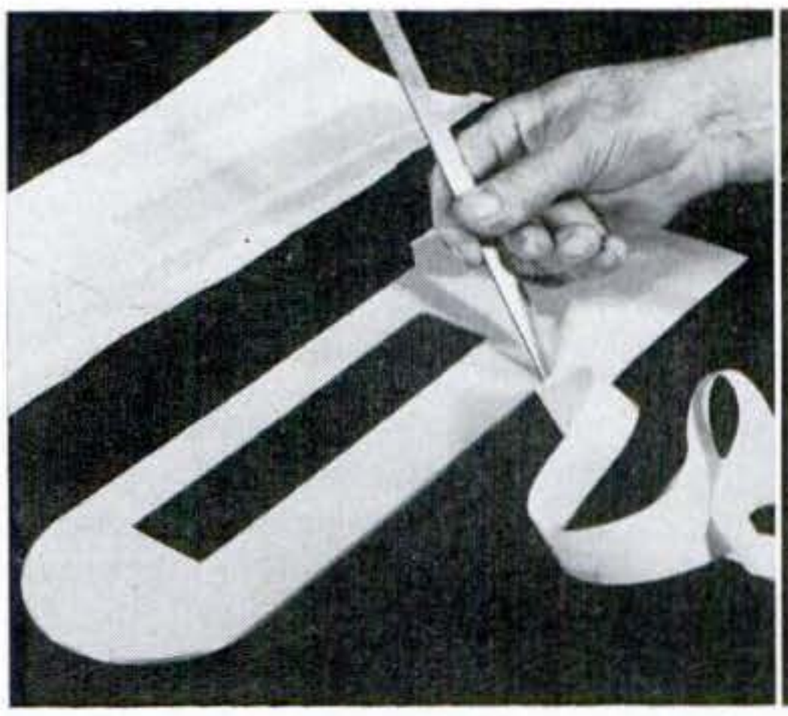
to a board, I dumped a good quantity of white glue on it. When the glue dried, I pried up an edge with a sharp knife and found that the blob of glue peeled off readily. This suggests the practicality of the film used to cover an area of a workbench where you do glue jobs. Also, try coating the face of the clamp blocks you use to protect the work when clamping glued assemblies.

I put a square of it down under the developer tray in my darkroom sink and found that it eliminated stain-removal chores I've always had with the basic fiberglass coating there. My wife Mary used some on the backsplash of the kitchen sink and above the range, and reported easier clean-up chores.

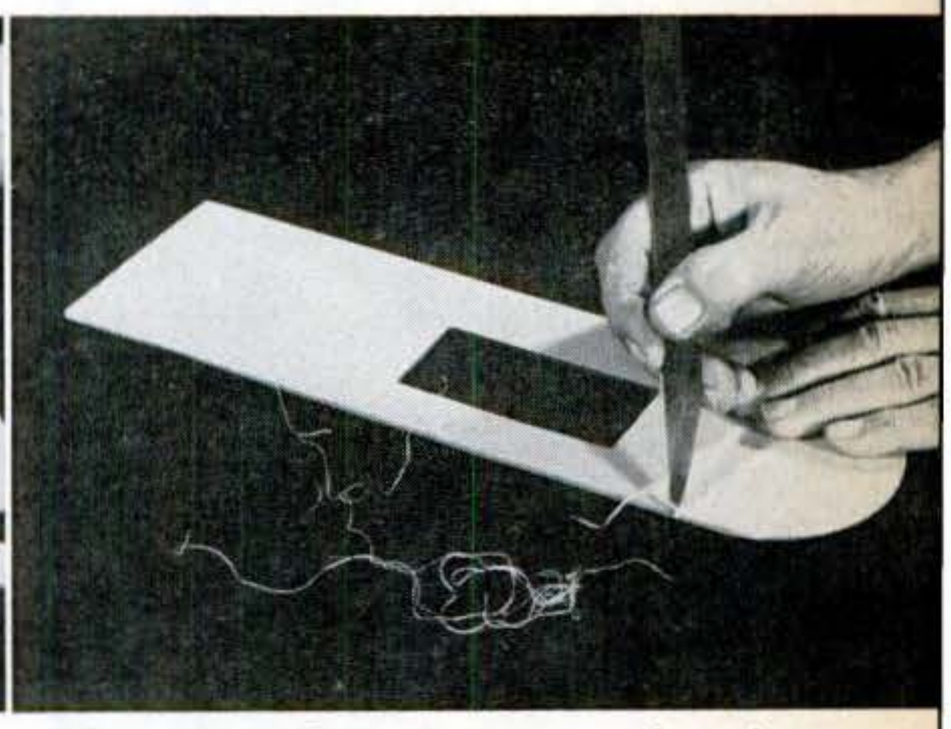
These were preliminary tries but

[Continued on page 126]

It's ideal for work surfaces or power tools



Work with a sharp knife to trim the material to size after you've pressed it down firmly in place. Put the scraps on backup paper for future use.

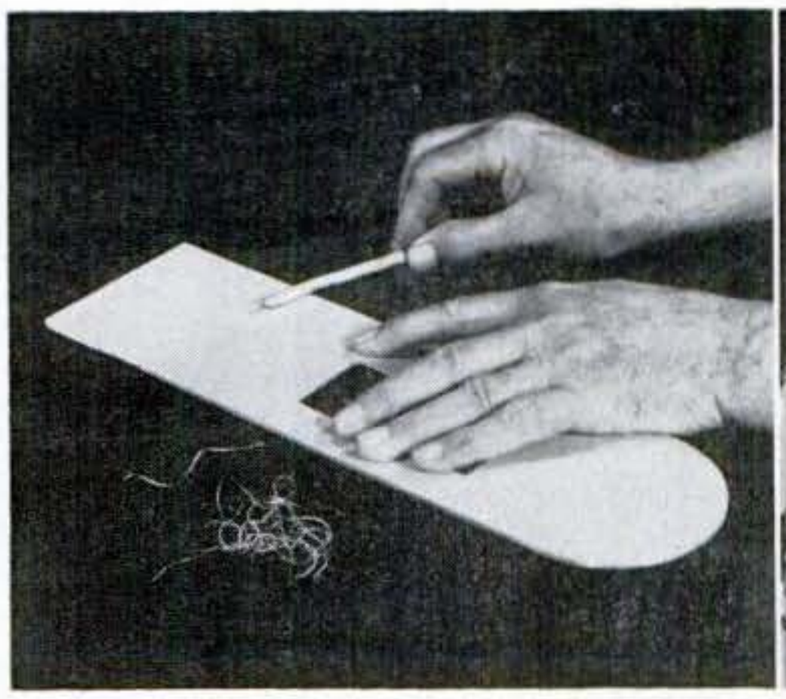


After the trim cut, go over the edge again with the knife held at a more acute angle. This is the skiving cut that forms a "ramp" on all leading edges.

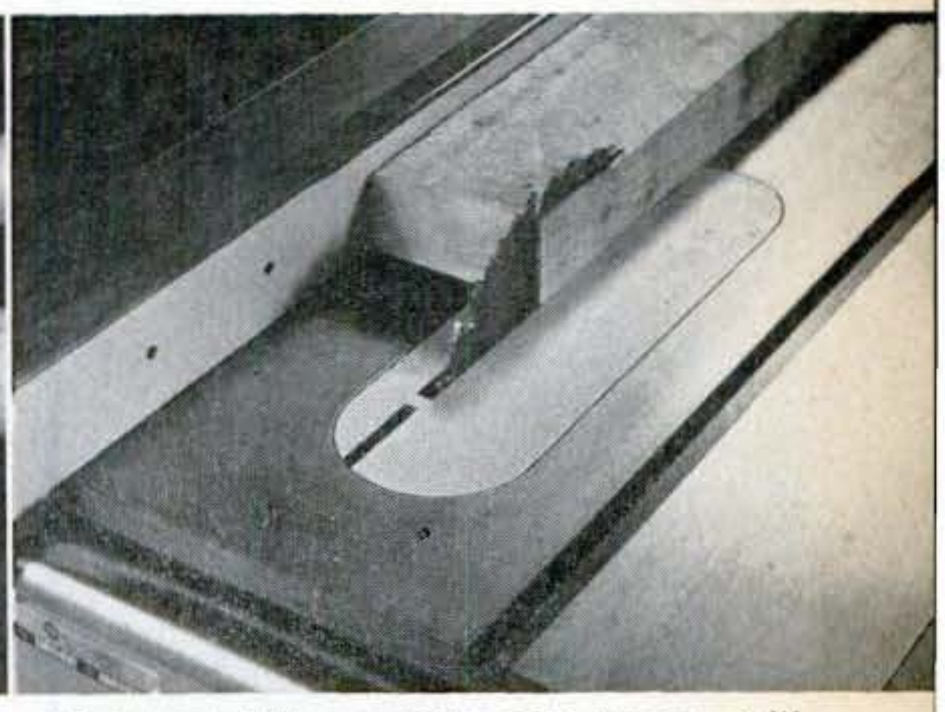
How to order Teflon for your own trials

The self-stick Teflon used in our trials is made by the Connecticut Hard Rubber Co. Orders should be sent direct to their plant at 407 East St., New Haven, Conn. 06509.

Each piece of 30- by 36-inch film will be shipped to you packed in a cardboard tube. Price per piece is $10.70. Specify which type you want—fiberglass-backed, or unmounted.



Now go over all edges with a piece of drill rod or a burnisher. It doesn't hurt to repeat the burnishing operation occasionally after part is put into use.



Finished job—a table-saw insert—will hold up well. Note film on rip fence, too. Author says if you must choose, film is most useful on rip fence.

—and now for those *non*-slip surfaces

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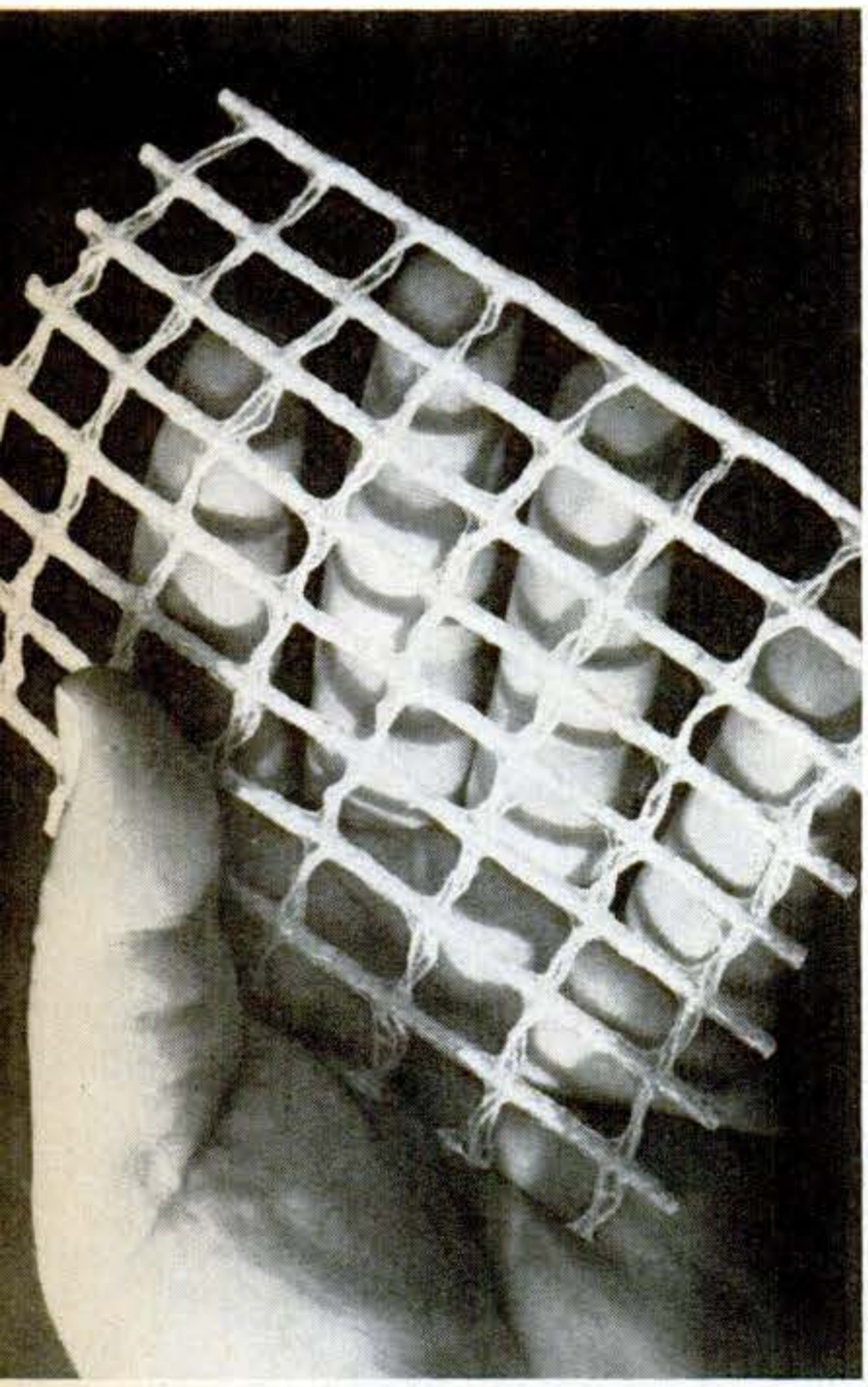
SLIP OR STICK Which do you want things to do? PS introduces a new product for each job

No Slipping and Sliding— This Plastic Says Stay Put!



Plastic-coated netting is good for dusty, dirty jobs. Debris falls through mesh, so plastic stays clean, grips better.

Put this unique nonslip stuff to work around your home. New from England, it's now available to you through PS

By JACKSON HAND

Let's just call it the exact opposite of slippery. Put something on it—just about anything—and it won't slide around. Jiggle it, jar it, nudge it, tilt it. What's placed on it stays where you put it.

And that makes a new translucent soft plastic called Dycem handy in a way that nothing else is handy. I put it on the face of my table-saw miter gauge and the stock stays in position, even when I'm making angle cuts. I put it under a table lamp that has a pull chain and tends to skid when you turn it on.

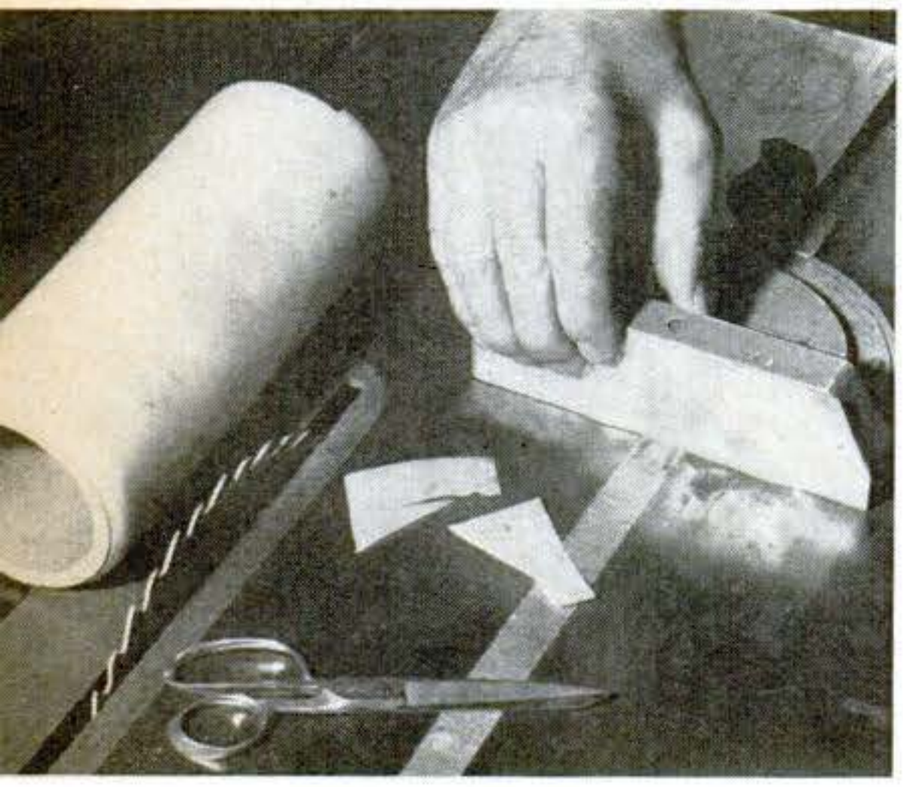
It works and that's nowhere near the half of it.

Dycem started its career in England, mainly in hospitals and for the physically handicapped. Gradually it spread to other fields—and to the U.S. Now, through an arrangement with Will Ross, Inc., of Milwaukee, PS brings it to you. It comes in mats, sheets, and rolls.

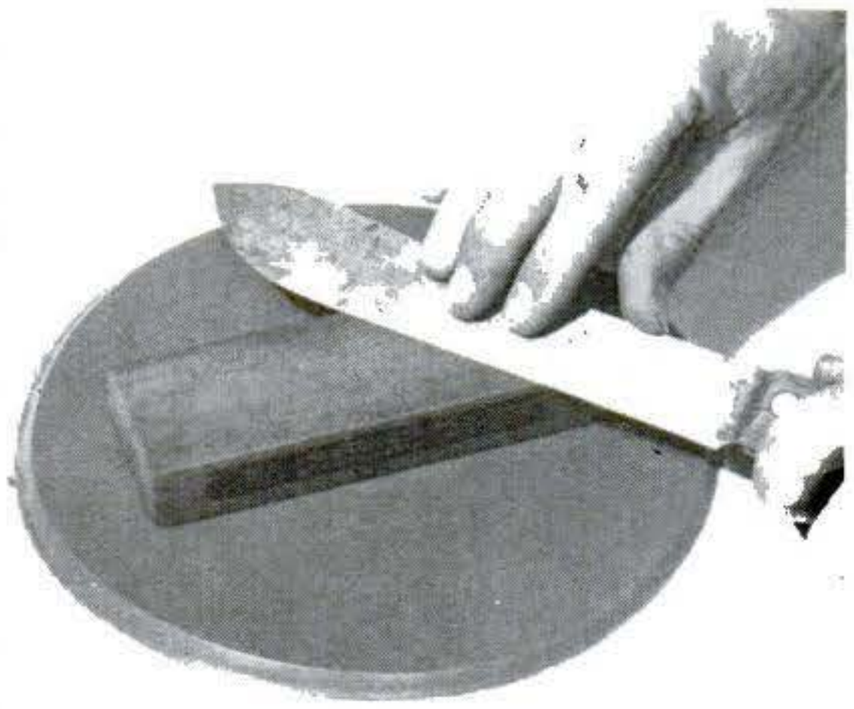
Dycem is a special PVC plastic. It comes already applied to trays, and coated onto netting. It's available with a stubborn self-stick backing, so you can stick it to things yourself, more or less permanently. With the backing removed, the mats or sheets lift easily from any surface they're used on.

The many, many uses. Of the hundreds of uses for Dycem, here are some that work into the activities of many of us . . .

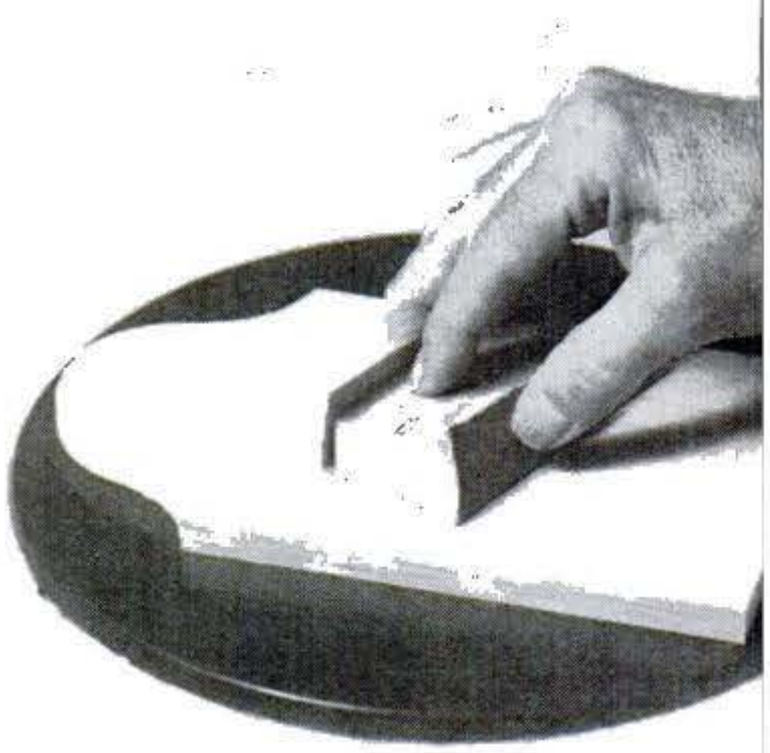
- On tool handles to give you a better grip. (It's an excellent insulator, by the way.)
- To hold tools on a slanting surface—such as an automobile fender—while you're fixing things.
- Under a paint can as you stir.
- On the bed of a drill press to hold stock securely.
- Under a scatter rug or a bath mat to prevent dangerous skids.
- As a gasket in nonheat situations.
- To provide extra grip when you're opening a twist-top jar.
- On a boat—or a camper—to hold just about anything from skidding about when seas—or roads—are rough.



Try it on your miter gauge to prevent stock slippage. Even miter cuts come out true. Use the adhesive-backed film here.



Sharpening stones stay put on a Dycem pad. No need to clamp the stone in vise or build bench-top frame to hold it.



Parts that are hard to hold for sanding are duck soup for sticky plastic. With no slipping, sanding is no sweat.

Turn the page to learn about super-slippery surfaces

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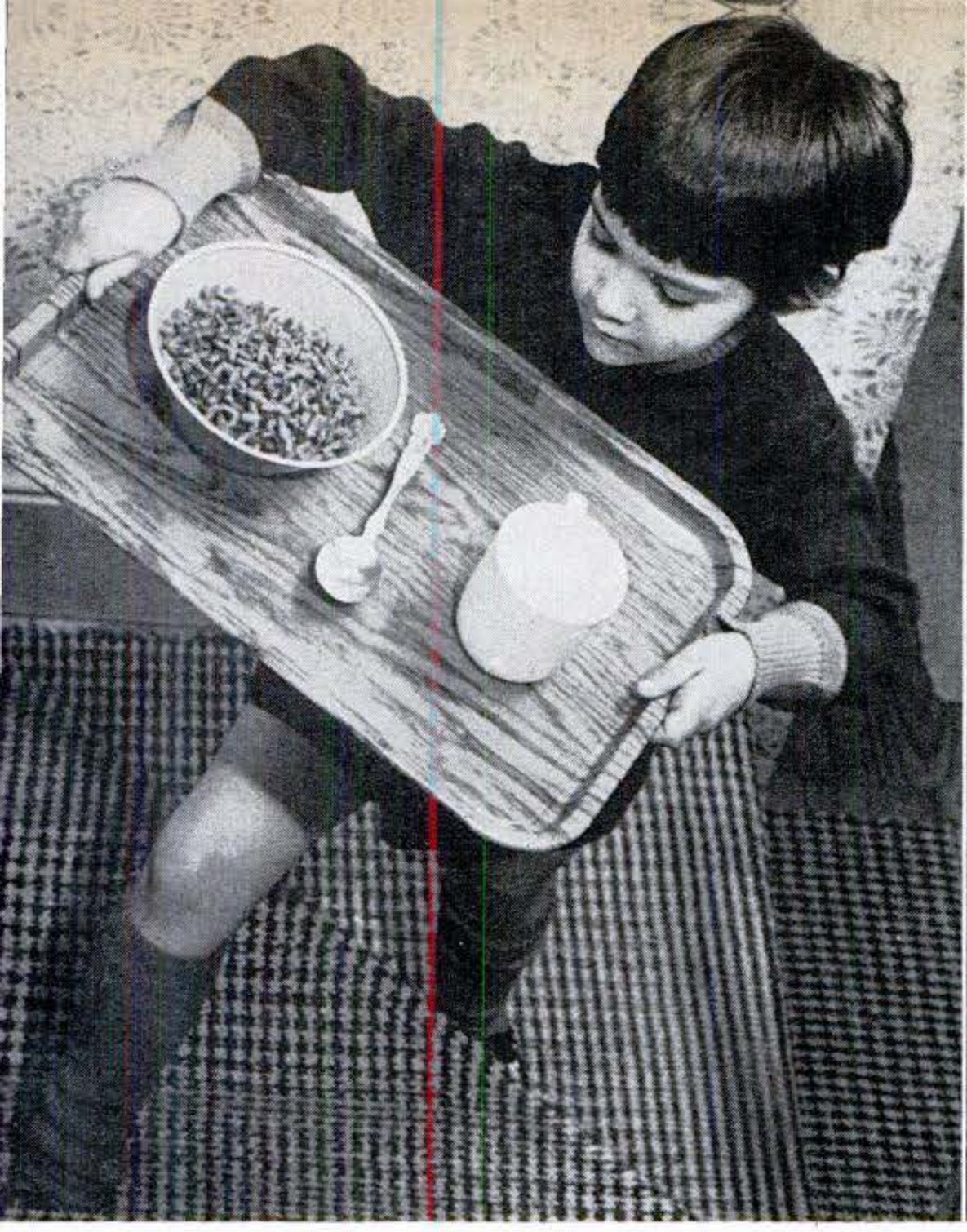


Breakfast in bed won't get spilled on the way to the bedroom. A child can serve with Dycem-coated tray.

Refreshment tray for your car's transmission hump is simple to make with plywood topped with adhesive-backed plastic.

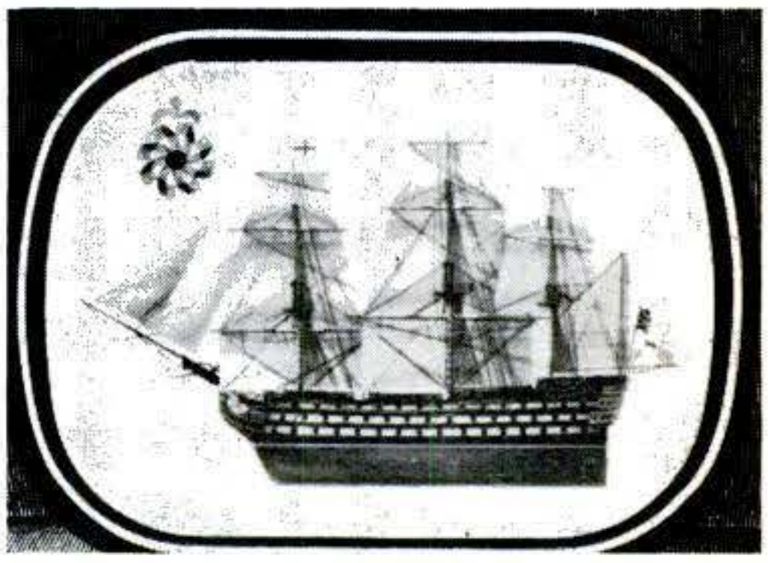
- Under your pet's food dish, to keep it in place.
- On a record label, a couple of dots to prevent the slip that causes tonal distortion.
- To hold a piece of stock too thin for convenient gripping in a vise.

One of the most surprising features of the material is that despite its seeming stickiness—you can rinse away any dirt that clings to it. Just hold it under the cold water faucet and it comes away slick and clean and smooth.

Thinking about the eyesore factor? There is none. You can get it in white, red, green, blue, yellow, or orange—and that variety will team up with just about everything. PS

How to order Dycem

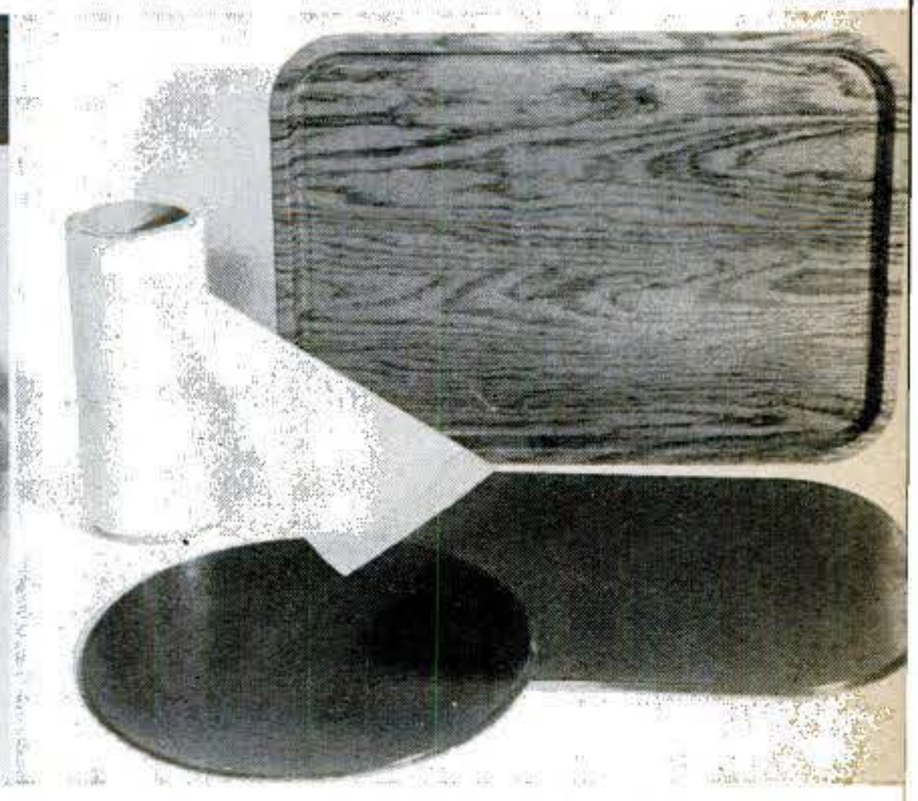
Want nonskid plastic working for you in your home? Sample packs of Dycem are available from Will Ross, Inc., Ventures Division, 4285 N. Port Washington Rd., Milwaukee, Wis. 53201. A sample pack includes two feet of 16″ reel stock; two feet of 8″ netting; one foot of 16″ adhesive-backed film for permanent application; one 10″-by-14″ pad. Price: $14.95 postpaid. For $19.95 you get the above package plus a Dycem-coated tray in a nautical design like the one that is pictured at the right. Colors in the sample packs are selected at random.



One of the first applications for the new sticky plastic was a serving tray. While the stuff will put an end to easy skidding, the Dycem coating is not sticky in the sense that a true adhesive is. Tip the tray far enough and objects carried on it can topple over.

On board your boat—that's a natural place for the plastic. It can stop skids even in high-vibration situations.

Mixing's made easier with a pad of Dycem on your kitchen counter. You'll like it under a phone when dialing, too.



You can buy it in sheets, rolls, and pads; purchase precovered netting and trays. Dycem has a soft, rubbery feel.

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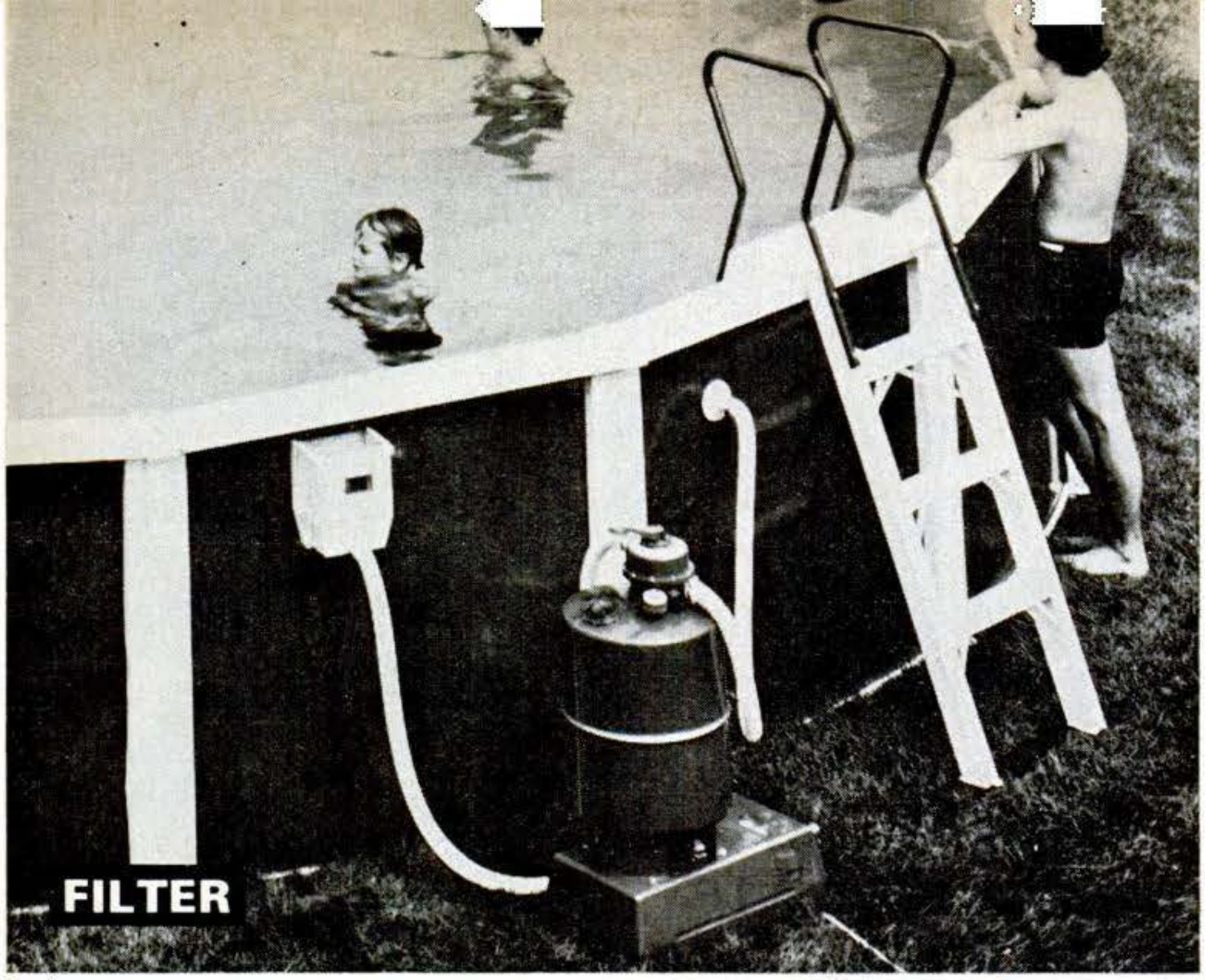
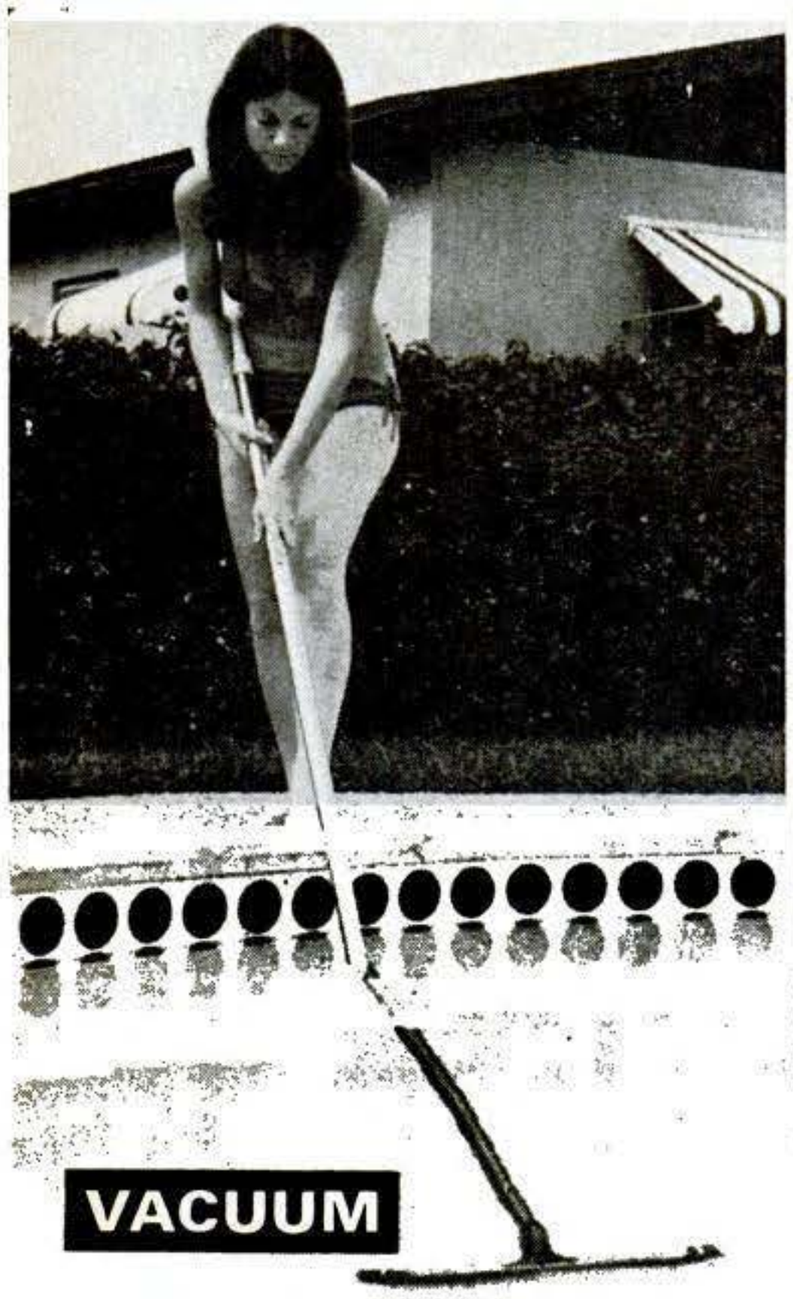
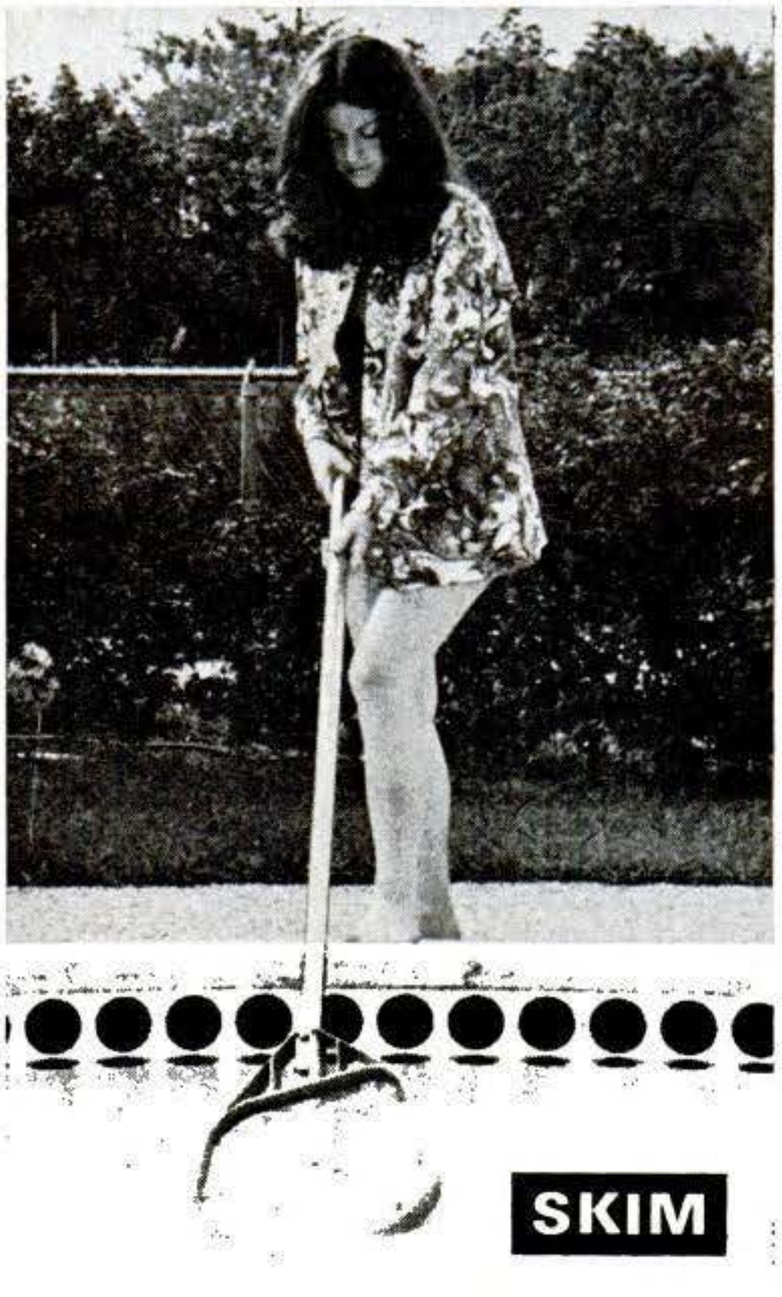
Keep Your

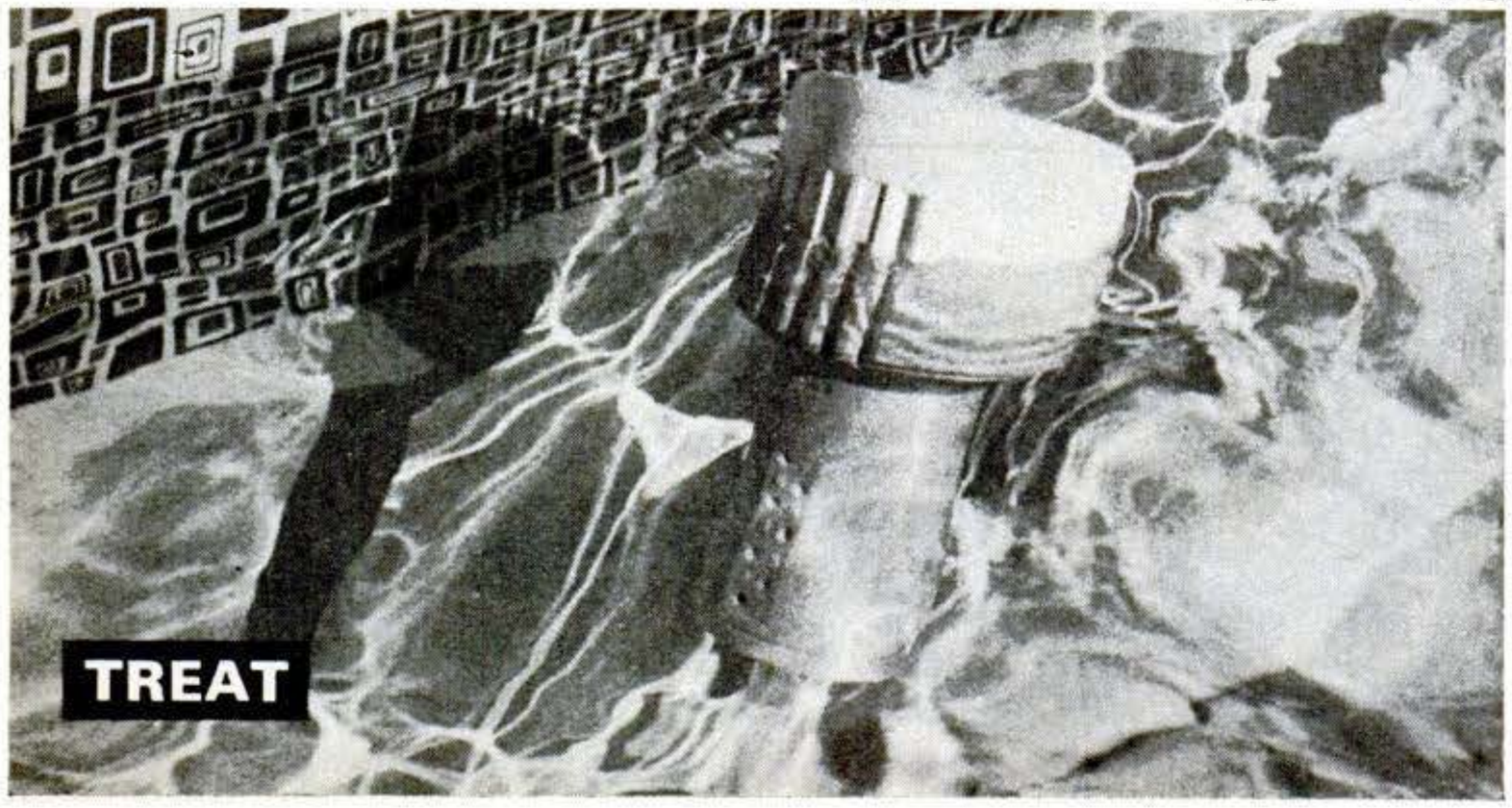
For a pool on-ground or in-ground, new products plus tested techniques can assure you of pure water

By GEORGE DANIELS









Water in a swimming pool has to be crystal clear and germ-free; it mustn't sting your eyes, bleach your hair, or corrode pool accessories. And it has to stay that way. The tap water you drink, if used to fill a pool, is seldom clear enough until the pool filter has removed considerable solid matter. (That's why filters usually require much more frequent cleaning just after the pool is filled than they do later on.)

And once that tap water is in the pool, exposed to open air, to swimmers, and to wind-blown debris, it won't stay germ-free without chemical protection. Yet overall pool water treatment requires very little effort once you have the basic facts on pool chemistry and filtration.

The filter. Whatever its type, it must be big enough for your pool. If it isn't, solids build up faster than it can remove them, and you have murky water, plus other side effects. Filters are rated according to pool gallonage. If you don't know the rating of yours, check it with the manufacturer by model number.

Filter types most widely used are diatomaceous earth (DE) and sand filters. Both do a thorough job. If

Take your pick of filters

Four samples of various filter types. First two, below, are sand filters: Big one (Cascade), for Buster Crabbe pool,

Pool Water Swimmable

you're buying, pick the type with the features that suit you:

DE filter particles are extremely small (far smaller than sand), so the spaces between them are equally small and can trap smaller particles than the sand type—even some bacteria. But maintenance of a DE filter isn't quite as simple as that of a sand type's. The fine-mesh elements (of various materials) must be coated with a layer of diatomaceous earth (like fine powder) at the start of operation, usually by pouring it into the filter intake.

When clogged by trapped solids, the elements are cleaned by washing off *both* trapped material *and* the DE layer. In many models, you simply reverse the flow through the filter, and "backwash" dirt and the used DE to a waste line. (Some types require other methods, such as opening the casing and hosing off the elements.) The filter must be "recharged" with a new DE layer, as at the start-up, before going back in operation.

The sand filter is a vertical tank filled (except for water space at top) with specially sized and graded sand. This is *not* mason's sand; you must get it from pool-supply houses. Solid matter is trapped throughout the sand bed's depth, as water is pumped through from top inlet to bottom outlet, where sieve-like devices prevent the escape of sand.

When clogged, the filter is cleaned by reverse-flow backwashing. This churns the sand with an inter-grain scouring action that removes adherents. Typically, the sand is replaced after four to six seasons.

When to clean either type is usually indicated by a built-in pressure gauge. When trapped solids blocking the filter pores increase the back pressure against the gauge to a point specified by the manufacturer, the filter needs cleaning.

Because of the wide variation in filter designs (including cartridge types like the one below right) the specific manufacturer's instructions are a must. If they're missing, and you're unfamiliar with the filter, get them before you operate the unit.

Pool chemicals come in a greater variety of forms (even for the same purpose) than most pool owners realize. Hence, directions for use vary so widely that instruction booklets often seem to give very different answers to the same questions. However, each is correct for the products to which it applies. So *always* follow the instructions on the container of the type and brand of chemical you are using.

Chlorinating compounds. Avoid the idea that these germ killers are "just chlorine." Half a dozen distinctly different chlorinating compounds are readily available in two broad categories: *unstabilized* (like calcium hypochlorite) and stabilized (like the chlorinated isocyanurates). All are intended to provide a "residual" in the water—the amount of the chemical that "resides" in the water as a germ-killer.

Unstabilized forms may be completely dissipated from the water by sunlight in as little as three hours, so frequent dosing may be necessary. For prolonged action, the compound is added to the water in the evening. Stabilized forms are far more resistant to sunlight and last longer in the water. So they are often added in larger amounts and less often.

The residual remaining in the water is measured in parts per million (ppm) with an inexpensive water tester sold by pool suppliers. If overall water conditions are right, one part chlorine per million of water is an effective germ-killing residual. (Instructions on stabilized types may run from 1 to 5 ppm, depending on brand, as the chemical remains in the water longer, using itself up on bacterial kill instead of dissipating from the water.)

But, formulas vary. The instructions usually include approximate amounts to be used daily or weekly, usually for a range of water temperatures. Check residual with a tester.

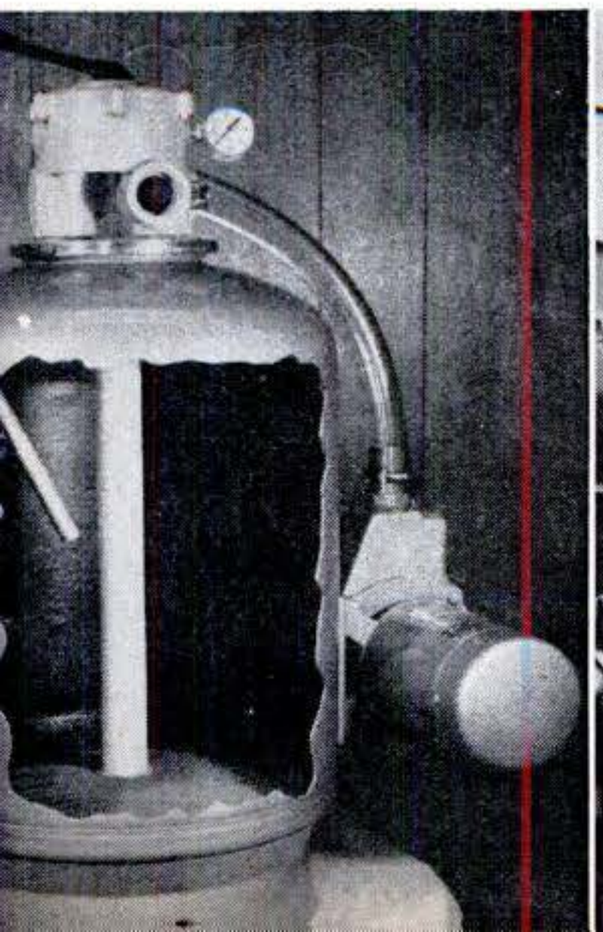
Whichever type of chlorinating compound you add to the water, part of it forms hypochlorous acid. This does most of the germ-killing, and the rest becomes hypochlorite ion. But the reading you get on your tester is the total of the two. At this point another aspect of pool water chemistry enters the picture.

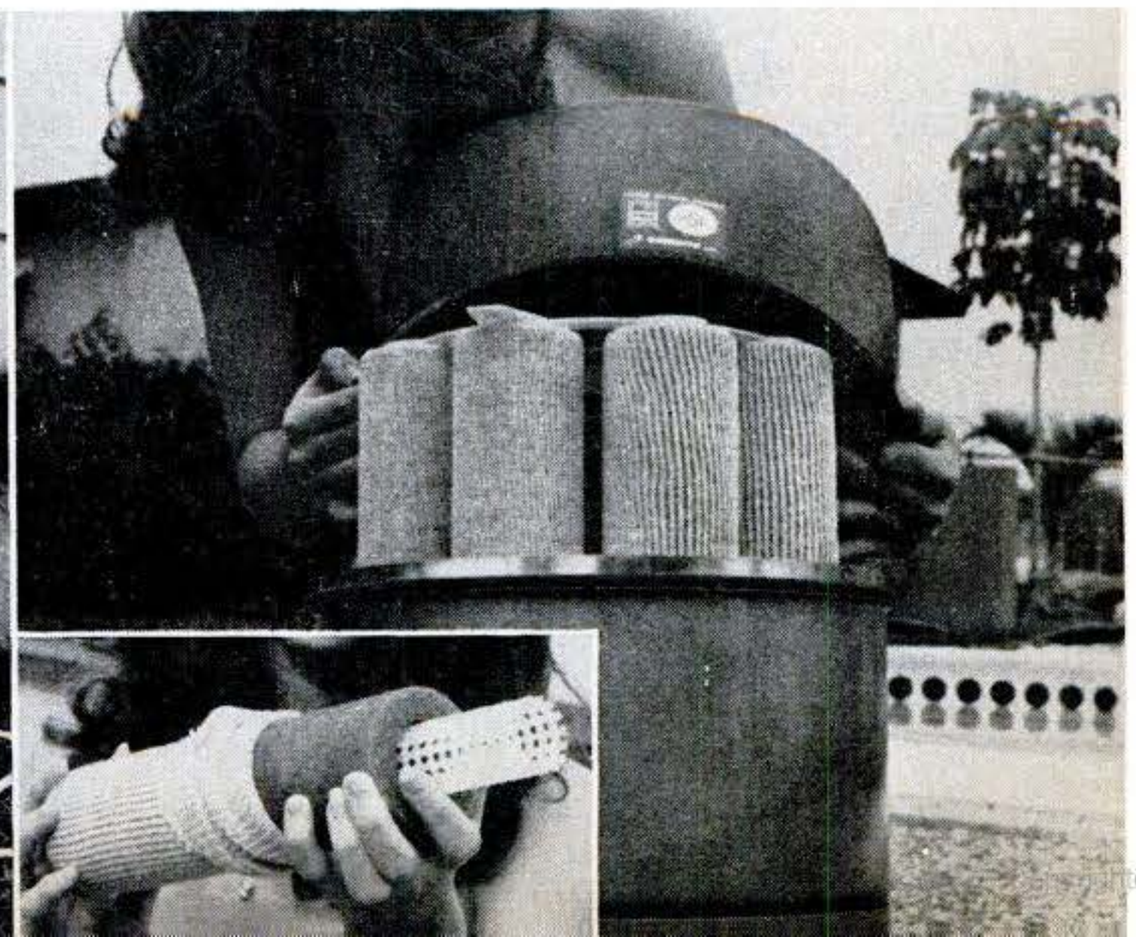
The pH factor. It can boost the germ-killing effect or knock it out so completely that the bacteria count soars and algae increase fast enough to actually clog the filter.

The pH is the overall measure of

Continued

has single-lever valve you set for different operations by turning handle (removed for photo). Cutway below shows simpler GM filter (without sand); pump at right forces water down through sand and out fine sieve at bottom. (Other types use ceramic element here.) Water then returns to pool through center tube. Slanted rod is anticorrosion anode. (Sears' 16-gal. filter is at the top of facing page.) Other common type is DE filter (center photo; see text). Cartridge filter, below, uses disposable fiberglass units by Johns-Manville (inset shows cloth stocking skinned back and polypropylene core).





Chemical treatments must be routinized. Some compounds, such as diatomite filter powder above, are designed for adding through system, though author does not recommend chlorine through filters. Simple chemical testers like one at right ($4) come with instructions. You take water samples, then drop in reagents.

the pool water's acidity or alkalinity. On the pH scale of 0 to 14, figures above the neutral 7 are in the alkaline range, those below 7 in the acid range. The commonly recommended range is between 7.2 and 7.6 (*slightly* alkaline) so pool water testers bracket this range by a few points.

Effect of high pH. If you add chlorine when the pH reading—also given by your pool tester—is at 7.5 (well within the okay range), about 50 percent of the chlorine forms germ-killing hypochlorous acid. But at a pH reading of 8 (out of okay range, *too* alkaline) the hypochlorous figure drops to a mere 20 percent—and at 9 it's close to zero.

Yet your tester's chlorine reading may still show an adequate chlorine residual, because it reads the total of the two chlorine factors. So, for germ-free water, you need a daily test for *both* chlorine residual and pH. (Excess alkalinity can also cause scaling on pool surfaces and pipes, sometimes chemically clouded water that a filter will not clear.)

Effect of low pH. Water in the acid range dissipates the chlorine much faster, makes swimmers' eyes burn, and eventually corrodes metal accessories and pump parts. A strong chlorine odor is often a clue. Your pH tester can confirm it.

Adjustment of pH in home pools is usually by trial and error, typically adding soda-ash to alkalize, or an acidifier like sodium bisulfate to acidify. Add the required chemical (as indicated by your tester), wait several hours for it to circulate completely, then retest to see if more is needed. Instructions on the container will serve as a guide.

Be sure the filter is running but *do not* add the chemical through it. And never add more in a single dose than specified, typically one pint of acidifier (or dry equivalent) or two pounds of soda-ash per 10,000 gallons of water. For small pH changes use smaller amounts, adding as needed until estimating comes easy.

You can also buy an "acid demand" tester that indicates the acid needed (in relation to pool gallonage) or take a water sample to a pool supplier for testing.

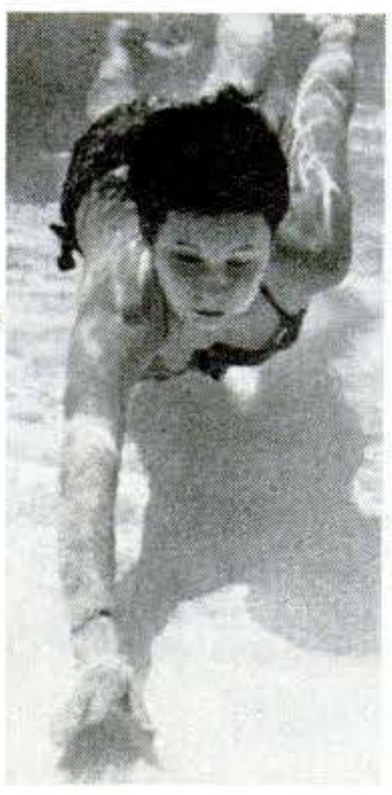
Handle all acid chemicals with extreme care, protecting your eyes and skin, and following the instructions on the container you are using. Never assume the instructions on one type or brand apply to another.

Hard-to-control pH may result from low "total alkalinity," a shortage of alkaline chemicals that normally give water its buffering capacity against sharp pH changes. The result: A little of any acid chemical can shift pH well into acid range.

If this condition (not common) occurs, 1½ pounds of sodium bicarbonate (from your pool supplier) per 10,000 gallons of water will raise the total alkalinity 10 ppm. Use enough to bring the pool into correct range—80-125 ppm. Check it with a

[Continued on page 132]

Free visual aid tests clarity of pool water



Plastic disk, red and black pattern on both sides, is placed on bottom of deepest section of pool. Pattern should be visible. Write Johns-Manville, Box 5705-C, Denver, Colo.

Polluted waterway? FLOAT a freshwater pool

By JACKSON HAND

So you've got this wonderful place right on the edge of the water. Only lately, the water has become so yukky that you hate to put your finger in it—let alone go swimming.

You might like the solution to that problem as it was worked out by Ed Kennelly for his place on a Long Island inlet—where a lot of pleasure-boat traffic mucks up the water.

His solution: float a pool of clean water—in its own liner—in the polluted waterway. The family-size pool where he and his wife and two kids swim (not to mention the neighborhood) is floating fresh and clear and blue, surrounded on three sides by murky brown water.

The floating pool is in many ways easier to build than its on-the-ground equivalent would be. Basically, it's nothing more than a rectangular frame of styrofoam floats exactly like those used for floating docks. Within this floating frame hangs a huge plastic bag—a liner like those in above-ground pools in a million backyards. You build the floating frame, then take the dimensions to a swimming-pool dealer.

The accompanying sketches show how the pool goes together, in rectangular form. However, one of the most interesting aspects of the project is that it can be just about any shape you want it to be. Modify the construction details to make it triangular—or pentagonal—or just about any other "agonal" that you'd like. The swimming pool outfit can make the liner any shape you want.

Planning the frame. As the sketches show, the "logs" of the rectangular frame consist of styrofoam batts enclosed in plywood channels—inverted. The outside of the channel is as deep as the batts are thick. The inside should go deeper, both to confine the tendency of the liner to "sway" with water movements outside, and to make it easier for bathers to clamber up on to the catwalk.

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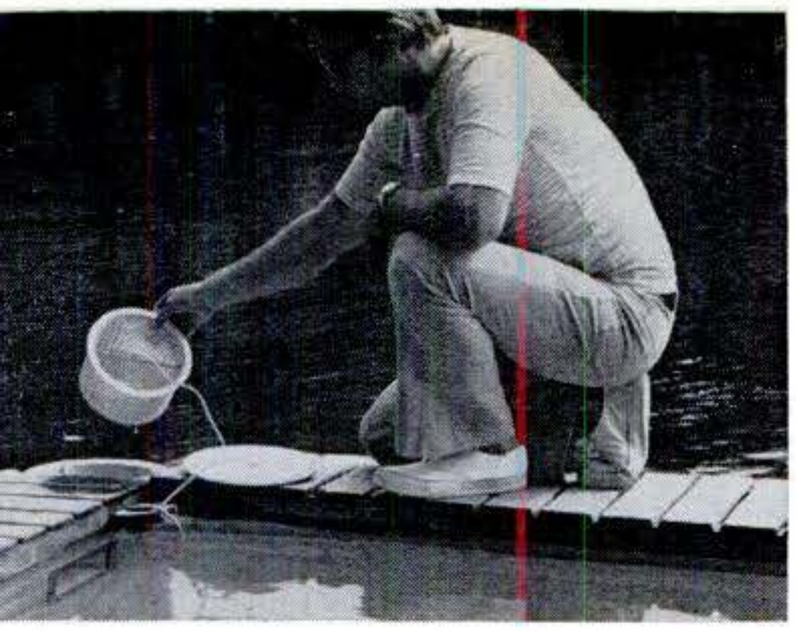
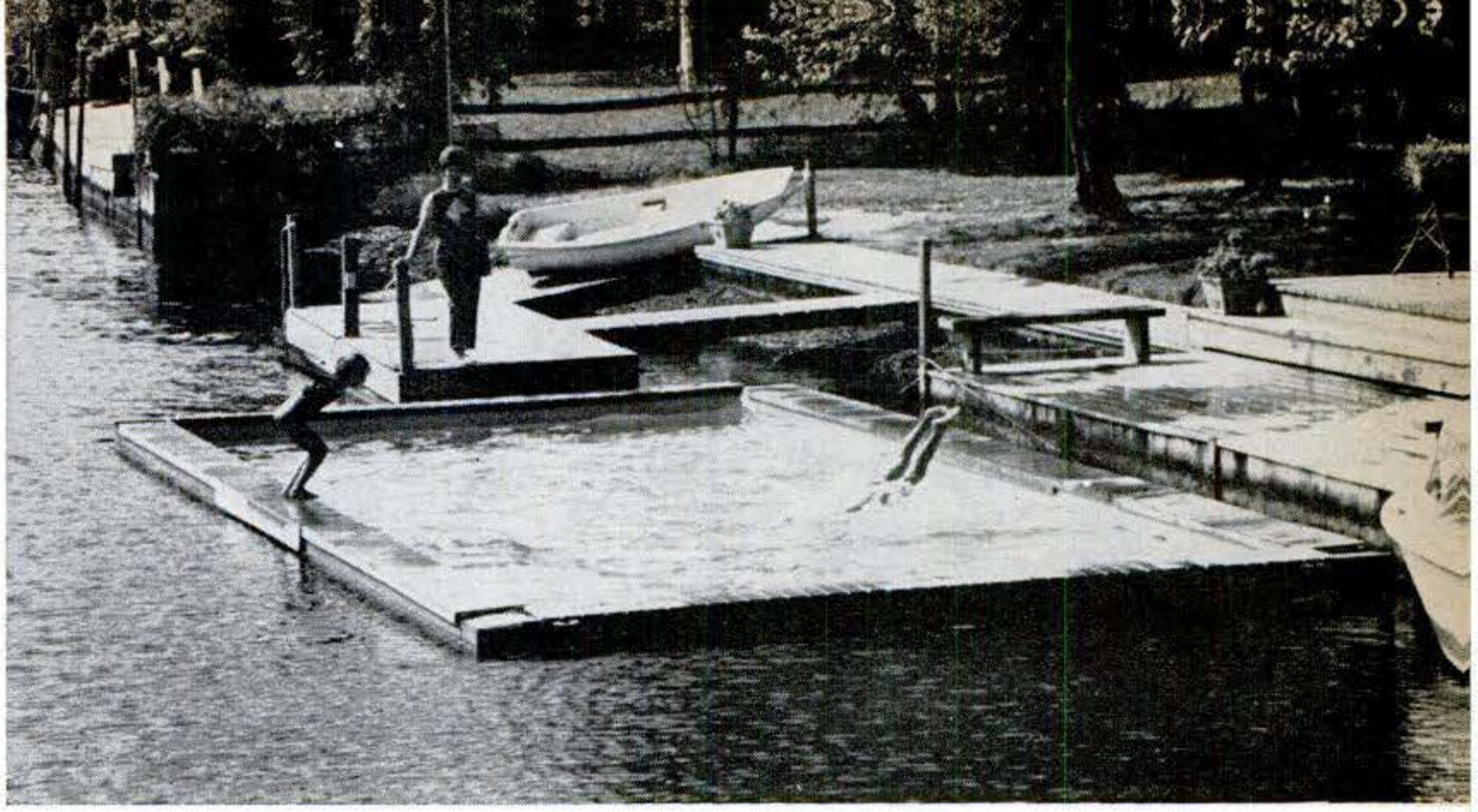


Filtration and purification is standard system housed in one corner unit. Pool is dismantled for winter storage, so water maintenance is seasonal only.

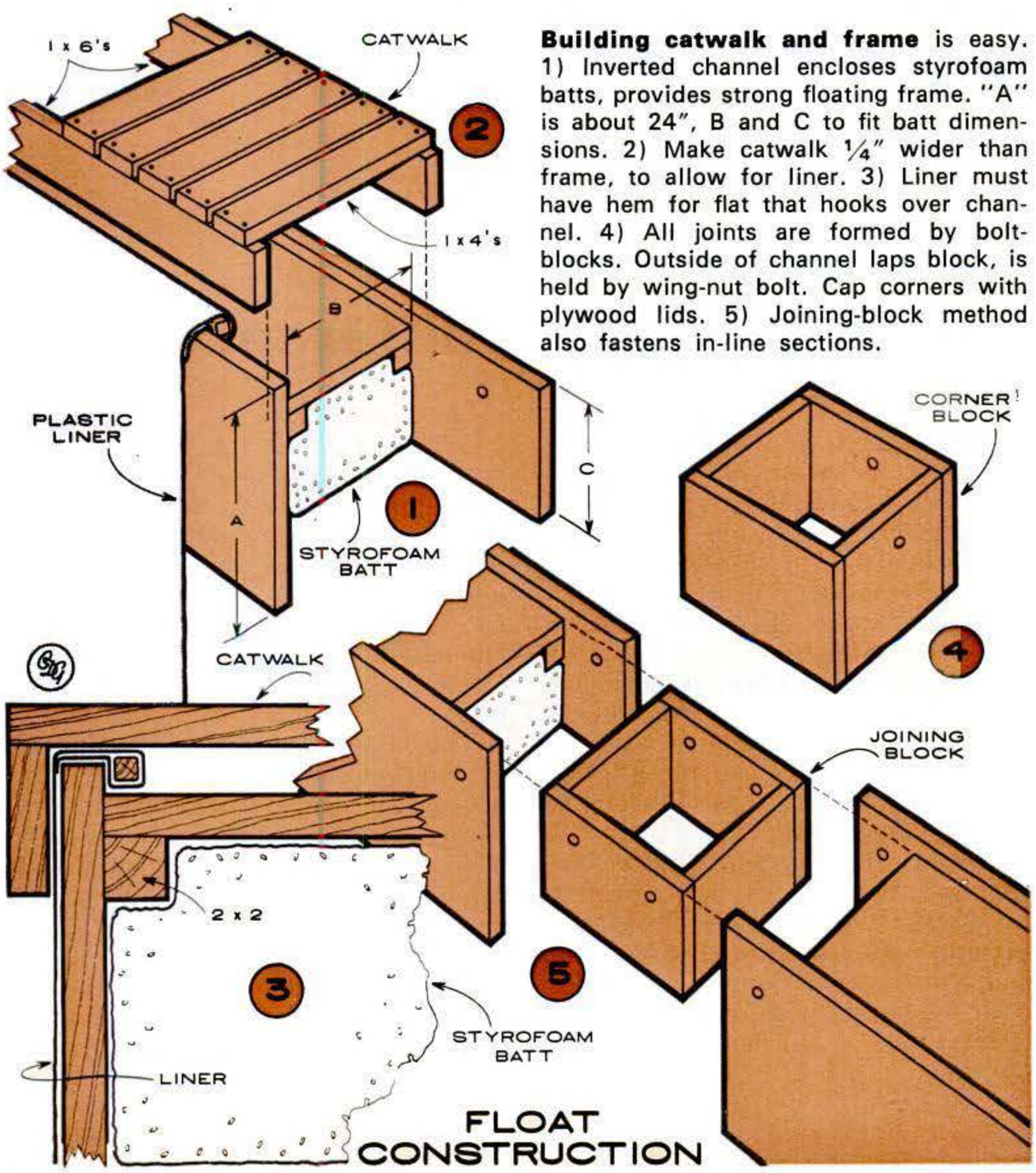


Besides providing a place to sit and walk that drains quickly through the spaced crosspieces, the catwalk acts as a stiffener where two "logs" are joined, end to end—as they may well be on the long sides of your pool. When you lay out the pool, be sure that no joint in the catwalk coincides with a joint in the logs.

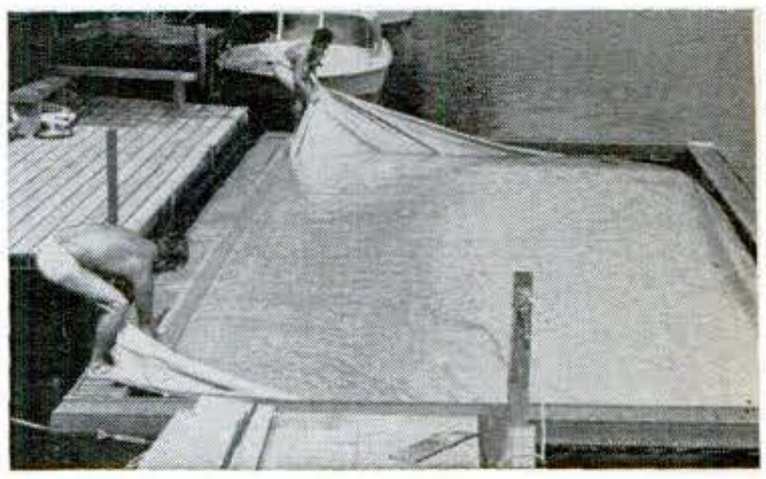
The batts should be a snug fit inside the channels. "Log" length, too, depends on the length of the batts you buy. Generally, you'll want to work in unit lengths of 16′, both because that dimension matches the standard lengths of plywood sheets and batts, and because a 16′ length is about all you'll want to wrestle with, assembling and disassembling your pool, spring and fall.

Note: Exterior-grade plywood, treated with a wood preservative, will last many, many seasons in the water. But be sure to use aluminum nails and plated bolts.

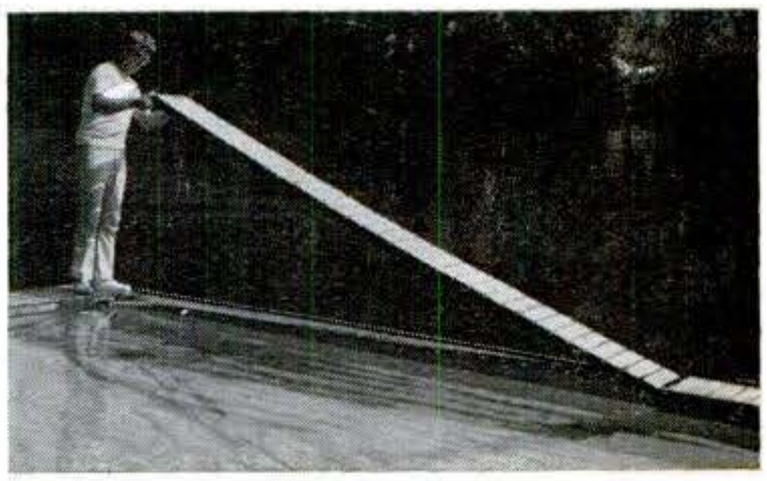
Notice that the joining is engineered on the "one-bolt" principle so every joint is flexible. This is important, because wave motion (even on an inland lake) could produce damaging stress on stiff, rigid joints. PS



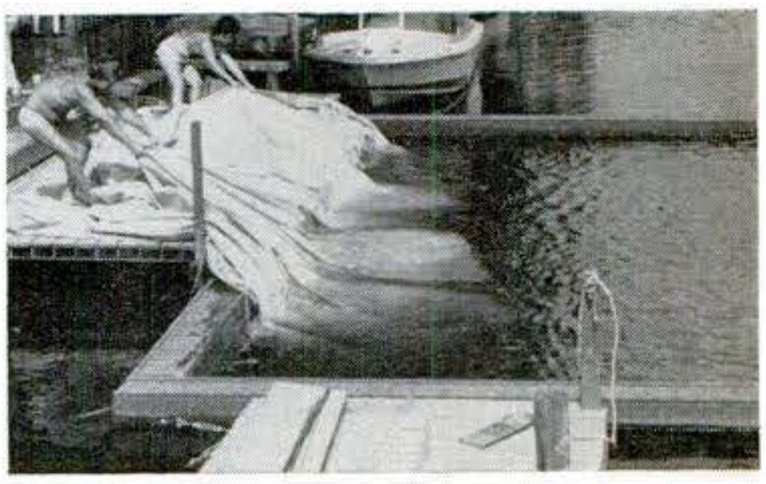
Building catwalk and frame is easy. 1) Inverted channel encloses styrofoam batts, provides strong floating frame. "A" is about 24", B and C to fit batt dimensions. 2) Make catwalk ¼" wider than frame, to allow for liner. 3) Liner must have hem for flat that hooks over channel. 4) All joints are formed by bolt-blocks. Outside of channel laps block, is held by wing-nut bolt. Cap corners with plywood lids. 5) Joining-block method also fastens in-line sections.



Float liner into place within frame, atop polluted water. Fill with pure water as you would any on-ground pool.



Catwalk around pool adds strength, creates diving ledge and seat, locks edge of liner to frame, as shown in sketches.



Haul liner out of frame, in fall, letting waters drain together. When dry, fold to store with unbolted frame units.

Rounded slat, slipped through hem at each edge, is what holds liner securely within frame while it's filled with water.

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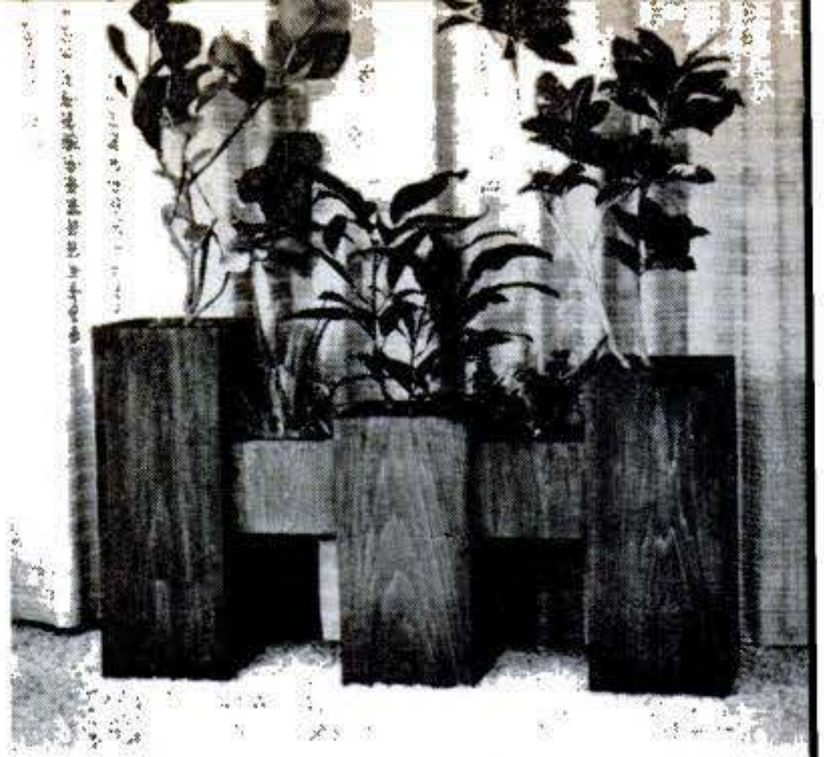
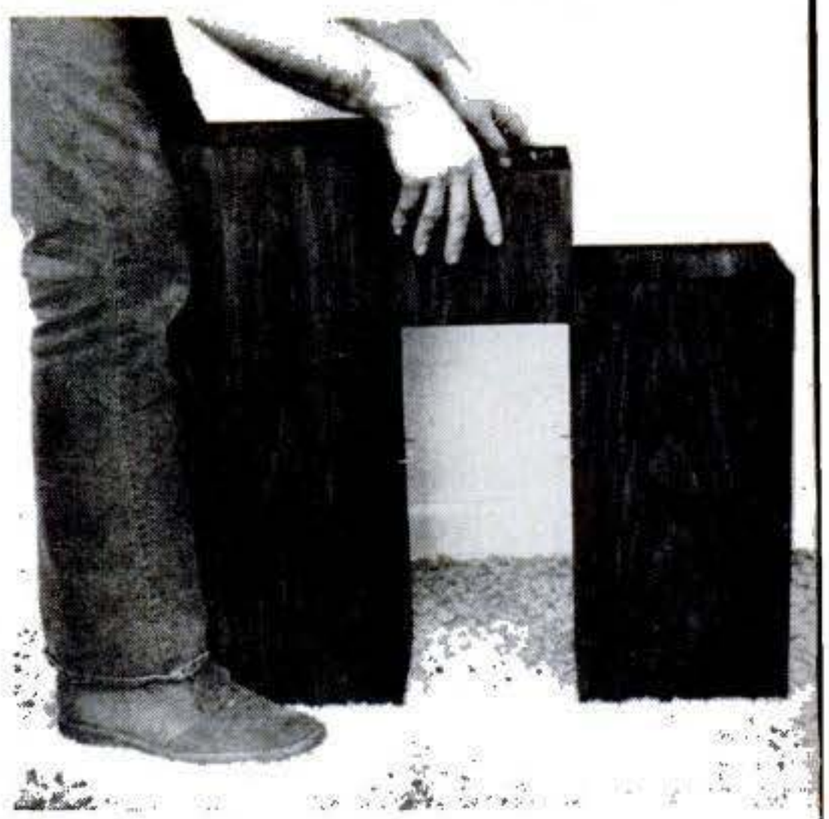


Planter can go together in a straight line or it can fit a corner. Three floor modules are of different heights to give you extra flexibility in arrangement.

Floating modules slip in between floor units and rest on dowel-pin supports. Sketch at right gives assembly details.



Modular Planter: Make it in a weekend—arrange it in a dozen different ways

By BILL COYLE

This eye-catching planter with the modular design is for anyone whose favorite house plants deserve a nicer stage for doing their act. More than that, it's designed for the nonprofessional home decorator who can't—or would rather not—make up his mind. Since the individual modules are not permanently fastened together, they can be shifted easily around to suit different room layouts. Whether you assemble them in a corner, under a window, or use them as a room divider, the choice of more than a dozen combinations is yours.

Building the planter is a cinch—strictly a one-weekend project for any home woodworker. The one power tool required is a radial-arm or a table saw, for cutting the miters.

Materials are also minimal. A complete list includes about 24′ of 1-by-10 pine, 6′ of 1-by-8, a length of 1/8″ dowel, a handful of 1¼″ finishing nails, white glue, wood putty, stain, and varnish.

The sketch shows dimensions. Here's the procedure I recommend for making your planter: Start by cutting the side panels for all five modules. First, cut the parts to length, then rip the miters.

Getting it together. Before assembling the modules, nail and glue the support cleats in place. To assemble, apply glue to mitered edges and clamp with corner clamps. Then reinforce the joints with finishing nails. I predrilled the nail holes to prevent splitting.

Note that when the finished units are arranged, the small floating units are supported by dowel pins projecting about ¾″ from the sides of the floor units. On any side that may require these dowel supports, drill two ⅛″ holes 10″ up from the bottom, and about 5′ apart on center. Then cut a 1½″ length of dowel for each hole.

The number of sides you prepare with dowel supports depends on the planter arrangement you plan to use. But by preparing three sides of each floor unit you'll have the option of any of a dozen or so possible combinations.

Finally, don't glue the dowels in place. Those not in use can then be hidden by pushing them in flush with the planter surface.

When the carpentry work is done,

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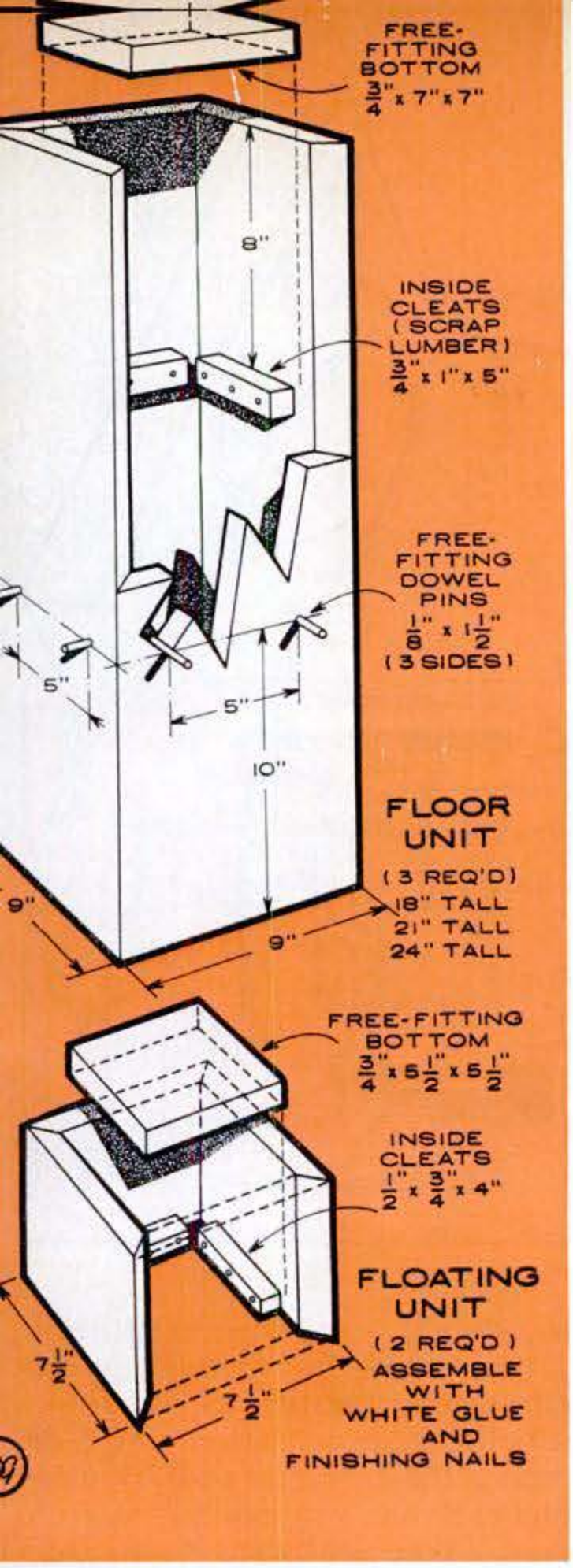

ou're ready to finish the planter. pply wood putty to the nail holes. and all the corners and outer surces. Make sure you remove all ane marks and glue smears; they'll ow up under the stain.

Now for the stain. The choice of ain is up to you, but it's best to ay away from the mahogany stains, pecially those in the red range. hey don't look natural on pine. ou're better off with one of the anque-pine stains, the kind that gives ew white wood an aged look.

Whichever you use, apply it acrding to the manufacturer's inructions. And don't forget to stain e dowel pins so that those not in se will blend in with the surface nish when pushed in flush.

When the stain is dry, finish up ith at least two coats of varnish, nding between coats. Finish the anters inside as well as out to proct the wood against moisture and prevent warping. Exposed end ain—always a problem on stained ood—was dealt with by brushing n black enamel, which provided a ce accent. PS

ONE-WEEKEND PROJECT • NO COMPETITION •

$200 AWARD EACH MONTH

If you have fresh, up-to-date design ideas, they may be worth money to you. We're looking for good small projects, imaginative, well-designed, and simple enough to be completed in a weekend. You will receive $200 for each project we choose for publication. Send as many entries as you wish.

How to qualify. Any small project you've designed and built yourself is eligible. Send your best photograph of it, plus a rough pencil sketch (our artists will redraw it in ink) giving all dimensions, and no more than one typed page (double-spaced) of explanation, including any special construction tips. Print your name, address, and social security number on each item in your package. *Do not send the project itself.* If we later need to photograph your project in our studio, we'll send for it and pay postage. Keep the negative of the photo you mail us (black-and-white prints preferred, though color is acceptable) in case we need it to improve print quality.

What type of project? We want ingenious, functional items built of nationally available materials—wood, plastic, metal. (For a hard-to-find item, list your mail-order source.) Readers should be able to duplicate your project in an average home shop, using hand or portable power tools. Ideally, a project should be:

- of clean, contemporary design . . .
- a solution to a common problem . . .
- of use in the home, yard, shop, or for recreation . . .
- simple enough to be completed in a single weekend, and to be presented on one magazine page.

Merely decorative items will not qualify, nor will overly familiar projects such as bookends, birdhouses, or utilizations of discard materials (bleach bottles, tin cans, coat hangers, baby-food jars).

Only accepted material will be acknowledged; none can be returned unless accompanied by a self-addressed, stamped envelope. We cannot enter into correspondence regarding entries. In cases of similar or identical entries, the one bearing the earliest postmark will qualify. Winners will receive payment immediately upon acceptance. (Projects that don't qualify for this competition may be purchased at our regular rates, for other use in the magazine.) Decisions by the editorial staff of Popular Science will be final.

The winning project in this month's competition will be presented in our November issue. To qualify, entries must be postmarked no later than August 1st. Send yours to: Weekend Project Editor, Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

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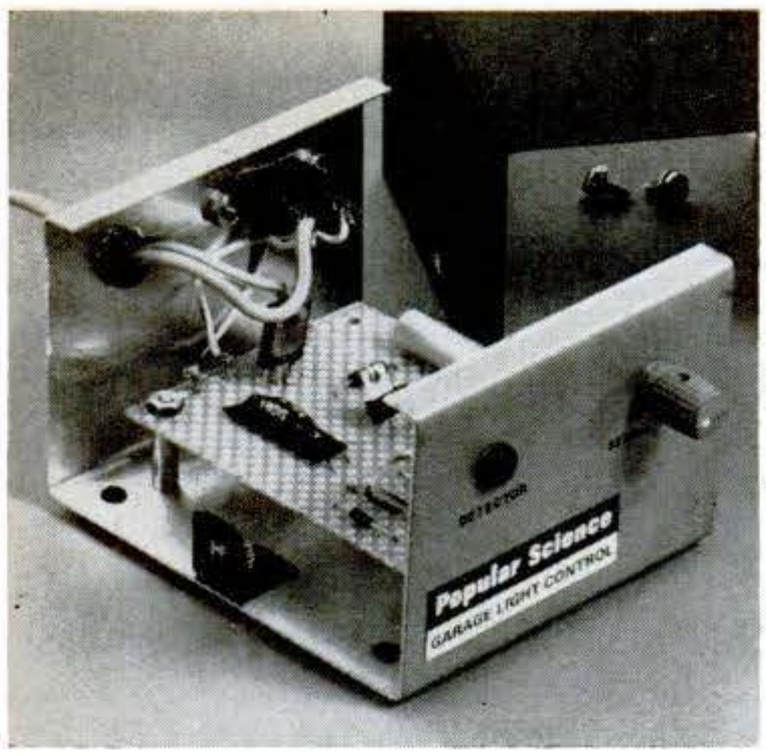
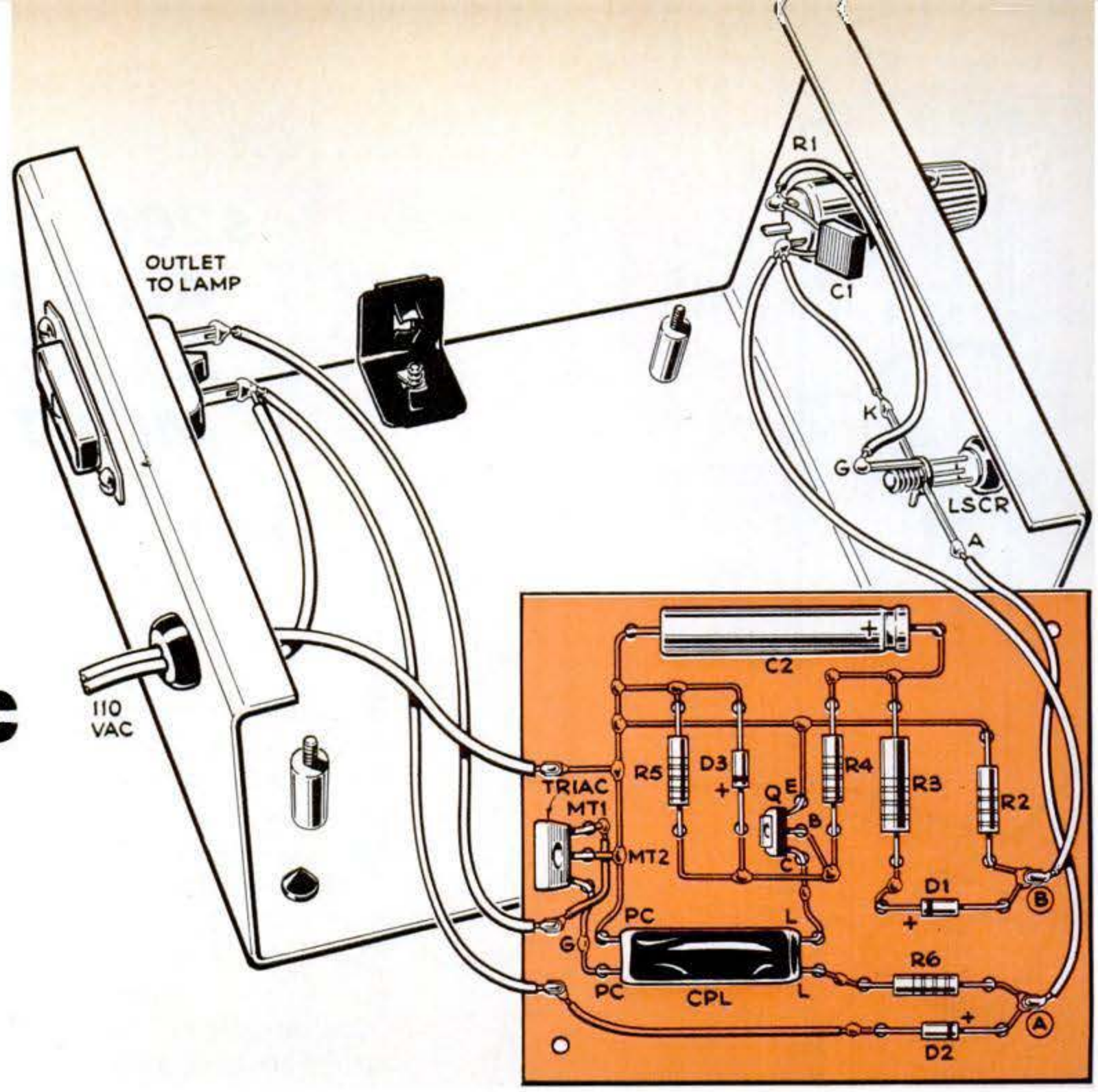




Automatic Garage Light Control

By C. R. LEWART

Mounted on a shelf or far wall in your garage, this clever light controller picks up your headlight beams as you drive in. In response, it turns on any light or group of lights in your garage, holding them on long enough for you to get out of the car and reach an exit. Then, automatically, the controller flickers the lights as a warning and begins to slowly dim them out.

No more, that kamikaze plunge across a pitch-black garage, past lethal rakes and bikes, yawning paint cans, and other booby traps. Now the lights are on for your easy departure from both car *and* garage —and you need never go near anything so mundane as a wall switch.

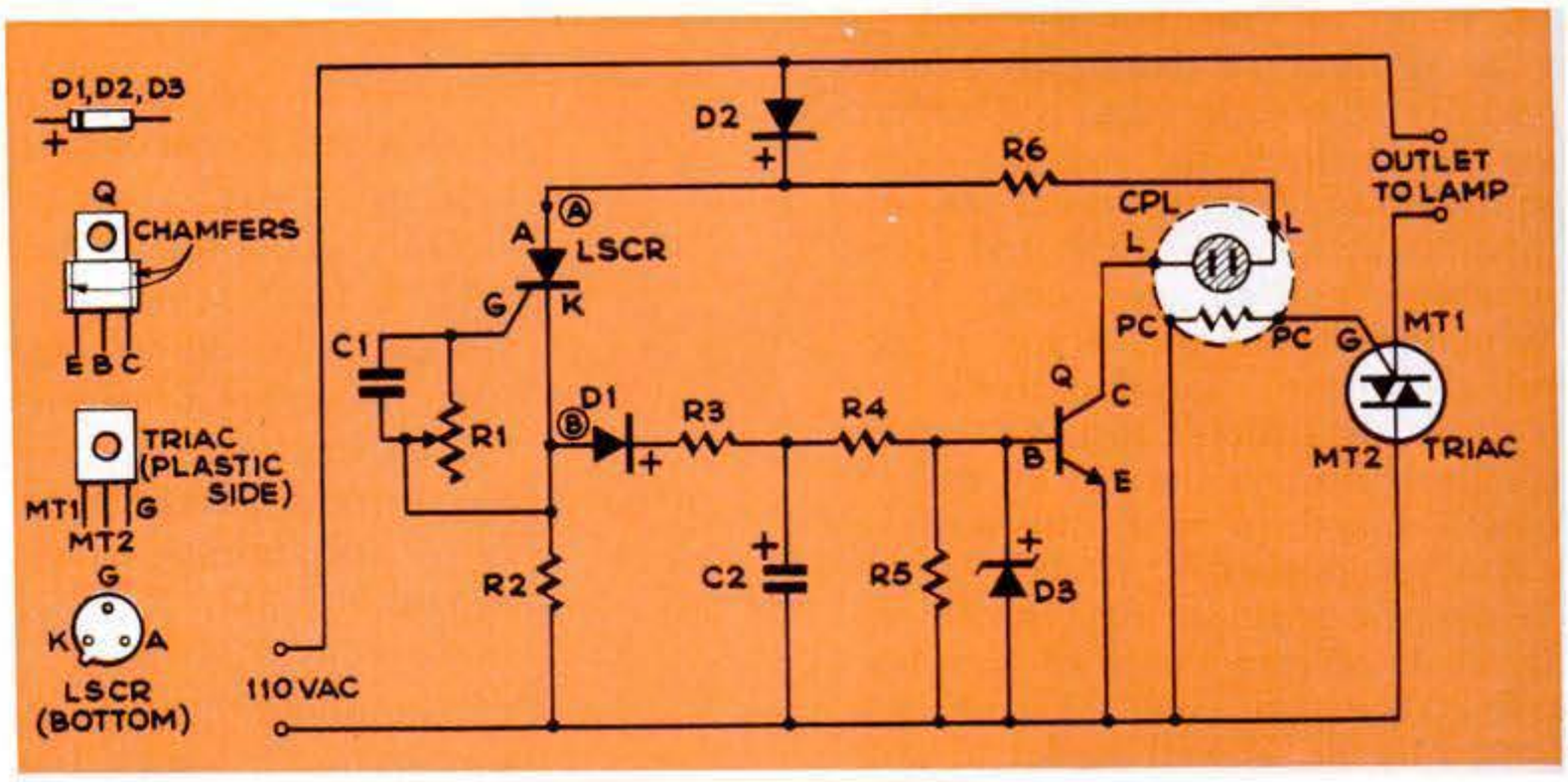
The controller's circuitry can easily fit in a 3"-by-4"-by-5" cabinet with all components mounted on perforated board as shown. The light-operated rectifier, LSCR, is held to the front panel with a ¼" rubber grommet. Keep the rectifier as close to the rear of the grommet as possible to prevent ambient light from striking its face.

The set up. Obviously, the controller must be placed in a spot that is struck by your headlights as you enter the garage. If you own two cars, find a location where their headlight patterns overlap.

Once it's mounted, plug your light source into the rear socket (max 800 watts) and adjust the sensitivity so the light just comes on when struck by the headlights. The sensitivity circuitry is deliberately minimal so that ambient light will be no problem—but don't place the unit where direct sunlight will fall on it.

Want manual control, too? Connect a bell button across points A and B on the circuit and the controller will turn on the lights when you push the button. Three minutes later, they'll turn off automatically.

If you hate being rushed, you can easily extend the time period before the lights go out. Capacitor C2 determines the time lag and, by using a higher value, you can increase duration. (You may want to consider how long it takes to remove groceries, kids, and dogs before making a decision.) By increasing the value from 10 to 20mfd, for example, you'll double the time. You can experiment with different values, if you wish, to fit your own needs. PS



PARTS LIST

C1—0.1mfd capacitor
C2—10mfd @150V capacitor
R1—1-meg. carb. potentiometer
R2—82,000-ohm, ½w resistor
R3—390-ohm, 1w resistor
R4—2.2-megohm, ½w resistor
R5—560,000-ohm, ½w resistor
R6—22,000-ohm, ½w resistor
D1,D2—Diode (Motorola HEP 156)
D3—Zener diode, 6.2V (Motorola HEP 103 or equiv.)
Q—High-voltage transistor (Motorola HEP S3022)
LSCR—Light-op. SCR, 200V (Radio Shack 276-1081)
Triac—Mot. HEP R1725
CPL—Light coupler Sigma 301T1-120A1 (SW Tech. Prod., 219 W. Rhapsody, San Antonio, Tex.)

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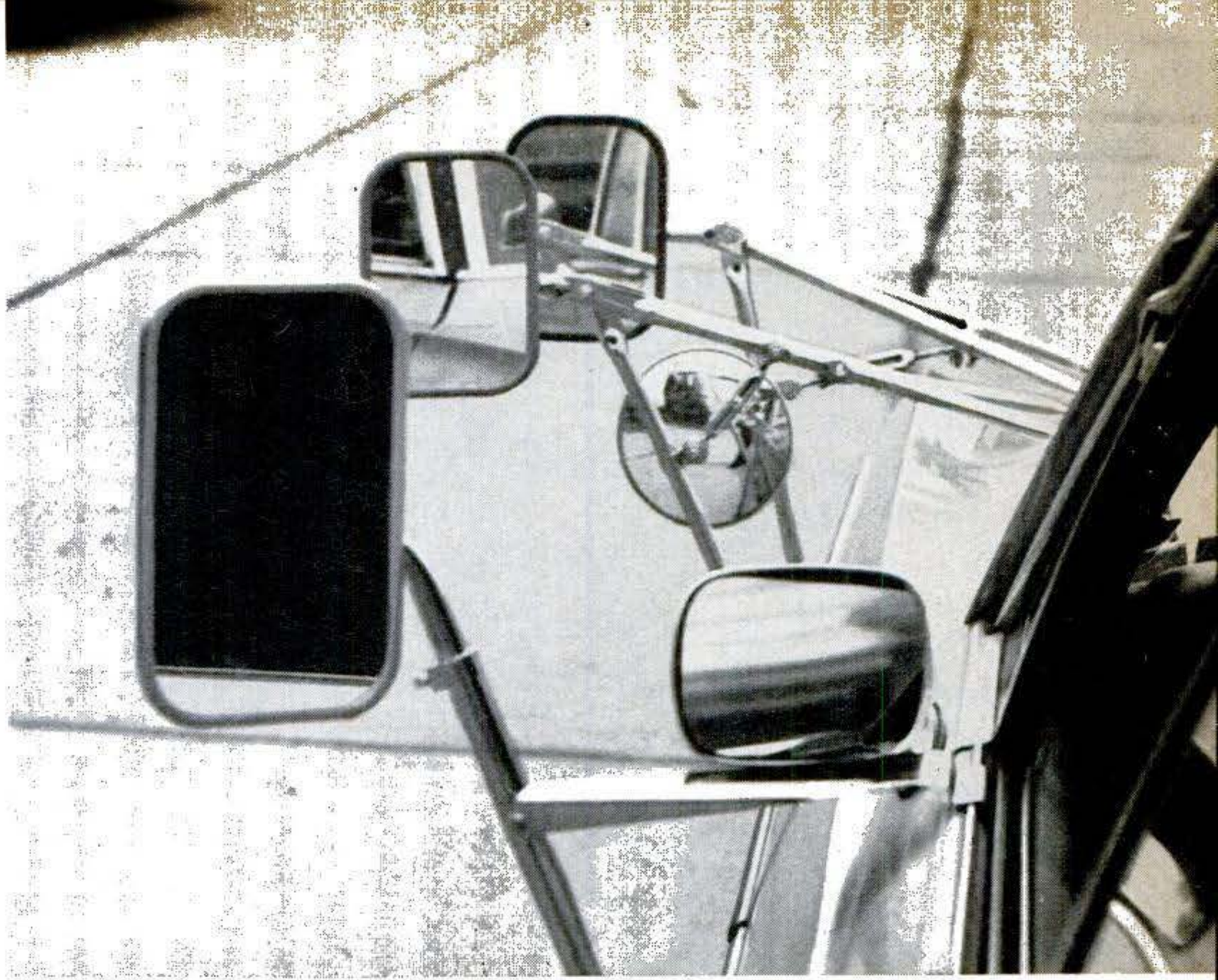
Trailer Mirrors—Eyes Behind Your Head

What kind, and where? Here's a guide to the mirrors you need when you tow

By ERNEST E. HICKMAN



What's best for you and your car? Here's a variety of types (from front): Yankee, Camper's Pride, and a Leggitt combined with Yankee round convex.

No politicians' smoke-filled room holds more compromises than those it takes to fit a specific tow car and a specific driver with just the right towing mirrors.

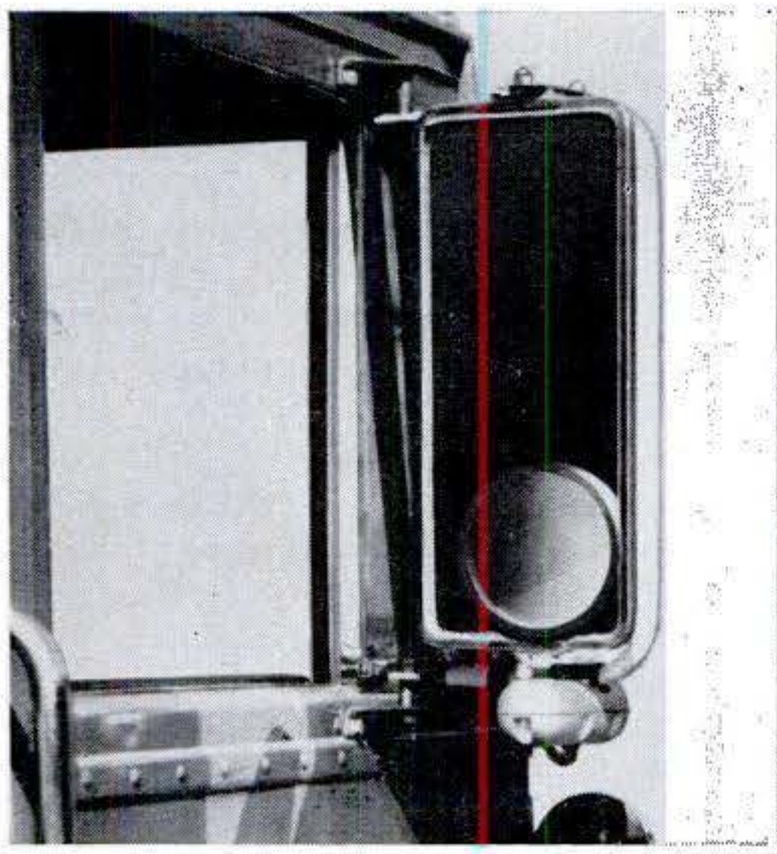
You must choose a mirror that's big enough to give good rearward vision, but small enough to minimize interference with forward vision. You've got to think about mounting location—fender or door—for your viewing angle and car. If you are short, fender mounts might interfere too much with forward vision. Door-mount mirrors would suit you better.

Door mounts work out best, too, where the same mirrors must be used on several cars. Elastic anchors

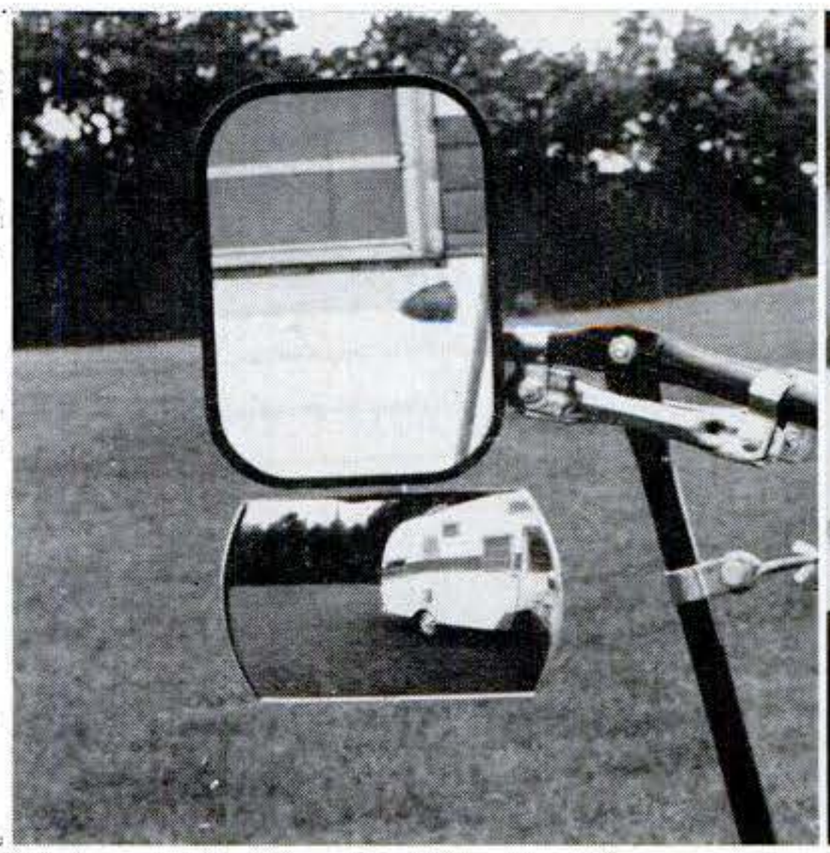
[Continued on page 131]

Field of view of Yankee door-mount mirror is indicated by tape. It gives broader view than that of flat fender-mount mirror, even though it's on right of car.

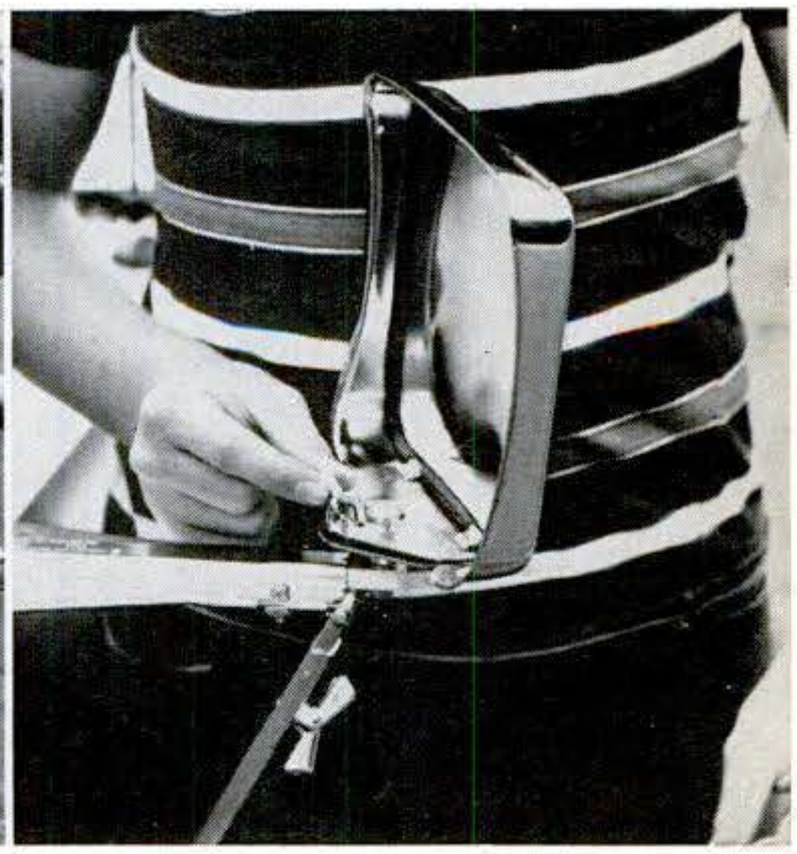
Location makes a difference: Tapes show viewing angles of McKesh mirror on door (widest) and on cowl, Tekonsha Silver Deluxe on fender (narrowest).



Controlling angle from dash is possible with new Westcotrol power unit (bottom of mirror). It's made by Electronic Enterprises, Fisher Bldg., Detroit.



Strohmeier See-All has angle of view similar to six-inch round convex, but image is larger. Author's favorite combination: Add a Leggitt (upper mirror).



McKesh mirror head is adjusted by big recessed thumbscrew clamps. The super-deluxe mirror is heavily chromed and expensive—$36 a pair from Wally Byam.

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Troubleshooting Your Car's

Emission controls create problems and adjustments that didn't exist on older cars. Test your knowledge of them with this quiz, sixth in a series

By MILES SCHOFIELD

1 *Engine continues to run after ignition is switched off*

Your late-model car is idling too slow, with a tendency to die. You figure that adjusting the idle is a simple job, so you get out your tools and have at it. It's been a while since you were under a hood, and you're surprised at the number of extra gadgets on the engine you don't understand. There is even a small cylinder mounted on the side of the carburetor, with a wire connected to it. But you're not interested in that; you just want to set up the idle a little.

After a long search, you finally find the throttle-stop screw. To your surprise, it isn't even touching the throttle linkage. You have to turn it a lot before the idle increases.

You suspect the choke and fast-idle are still on, but a quick check shows both are off. So you keep turning until the idle speed reaches a satisfactory level.

The engine idles fine now, and you shut the hood, pleased with your accomplishment. But after your first trip you notice a new problem—"dieseling" (the engine runs for several seconds after you turn the motor off). You get out your tune-up equipment and check timing, dwell, and idle speed. But they're all at the exact specifications called for in the service manual.

Because the dieseling started right after you adjusted the idle, it's a pretty sure bet that your adjustment caused it.

What did you do wrong, and why is the engine dieseling now?

2 *Car won't decelerate with foot removed from gas pedal*

Saturday morning is a time when neighbors and friends drop by, usually for relaxing talk while you tinker in the garage. But on this particular morning, a visitor drives up who is anything but relaxed. "My car is running away with me," he says. "A friend of mine just adjusted the idle speed, and now when the transmission's in third gear the car won't slow down when I take my foot off the gas."

You lift the hood and see a solenoid mounted on the side of the carburetor, with a stem that contacts the throttle linkage. There is a decal on the solenoid, but someone has painted over the lettering and all you can read is the word CAUTION.

You realize that the curb-idle on a car with an anti-dieseling solenoid is set with a solenoid adjustment. But the solenoid on this car looks different from the anti-dieseling solenoid on your car. It not only has a wire connected to it, but vacuum hoses, too. And there's that partially painted decal. The anti-dieseling solenoid on your car doesn't have a decal.

"Where did he adjust the idle?" you ask your friend.

"He turned the stem of that solenoid. And he had to turn it a lot, you know, before it even touched the linkage."

To see exactly how the car behaves, you take it for a test drive. After starting the engine, you pump the gas pedal a few times. Each time you lift your foot from the pedal, the engine speed immediately falls back to a smooth, steady idle.

Out on the highway, after the transmission has shifted into third, you take your foot off the gas. The car continues forward, with no engine deceleration. You brake to a stop and put the gear selector in low. When you press the accelerator pedal the car surges ahead. When you release the pedal, the engine immediately decelerates.

What did your friend's friend do wrong when he adjusted the idle?

3 *Smoke comes from oil-filler cap*

At stop signals your high-mileage car is giving out little wisps of smoke from under the hood. But the car runs fine, so you keep driving it until one day a guy pulls up beside you and asks with a smile, "Don't you know smoking is bad for your health?"

When you get home, up comes the hood, and you see the smoke is coming from the oil-filler cap. Your oil cap is the type with no hose connecting it to the air cleaner.

The smoking suggests a plugged PCV valve, so you pick up a new one at the parts store and install it. But, to your surprise, the smoking continues. You check the vacuum at the valve itself. It's strong, sharply pulling your finger against the end of the valve. Then you check the crankcase vacuum at idle by laying a piece of paper over the open oil-filler hole. The paper is not pulled against the tube, as it would be with a strong vacuum in the crankcase. Instead, it just sits there, and finally falls off.

You realize that the crankcase has to be airtight if it's going to hold vacuum, so you check the dipstick to see if the washer at the top is seated tight against the tube. It checks out fine. Then you look at the rocker-cover screws, because an air leak there would let outside air in and weaken the crankcase vacuum. But tightening the screws doesn't change the situation.

Then you suspect the engine has so much blow-by into the crankcase that the PCV valve can't handle it. You test by unplugging the valve from its grommet while the engine is idling. If the PCV valve were working to its capacity, then the engine should smoke much more when it's disconnected. But the smoke increases only a little. The PCV valve is obviously drawing on the crankcase, but having no effect.

What have you overlooked?

4 *Idle speed decreases*

When you first got your car running after the ring and valve job at 80,000 miles, you were really happy with it. The engine ran just like new, used very little oil, and the car felt like it might be good for another 80,000. After a few days of driving, you didn't feel as happy. The engine kept idling slower as the days went by. You had to reset the idle a little faster every three days. Not only that, the mixture seemed to be changing at idle, too. It was obvious something was wrong with the carburetion, at least that's what you thought.

But after inspecting the carburetor thoroughly, you found nothing wrong. The float level was correct, and so were all other carburetor specifications. You even checked fuel-pump pressure and volume, but found nothing deviating from spec-

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ifications in your service manual.

Then, just on a hunch, you pulled the PCV valve out of its grommet and put your finger on the end while the engine was idling. There was no vacuum at all. This accounted for the change in idle. The PCV valve seemed to be slowly plugging up.

You went to get a new valve, thinking your problem was solved. A few seconds after installing the valve, your hopes turned to gloom. It didn't make any difference. There was still no vacuum at the valve. What should you check next?

5 *Engine won't idle*

You just did a tune-up on your 1973 car. It starts and runs fine until it warms up. Then you open the throttle to let the fast-idle cam go off, and when you take your foot off the throttle the engine idles rough and stalls. The only way you can restart the engine is by pumping the throttle and holding it open about halfway. When you ease it back to idle, the engine dies.

You suspect the trouble is caused by something you did, so you go back over your work step by step. The points, condenser, timing, fuel filter, and air-cleaner element were all installed or set correctly. The only other thing you did was hook up your vacuum gauge to get a reading of idle vacuum, which took three or four tries to find a hose that supplied manifold vacuum.

Your engine has all the latest emission controls: air pump, vapor control, transmission-controlled spark, and exhaust-gas recirculation. You figure that when you had the vacuum hoses off to check the vacuum, you must have switched a hose to the wrong connection.

What is the one emission control that does not normally operate at idle, and would kill the engine if you accidentally hooked up the hose so it *did* work at idle?

6 *Your exhaust flunks the CO test*

You just bought a two-year-old car from a good friend. He had tuned it up before you bought it, and it runs beautifully, better than you would expect from a car with emission controls. Then you get caught in a roadside inspection, and everything passes except the CO emission check; the carbon monoxide is too high. You take the car to a garage that has a CO meter and they tell you that someone did a good job on the tune-up, but adjusted the carburetor for performance instead of emission control. Without taking anything apart, the mechanic makes some quick adjustments, and the CO comes down within state limits.

Did the mechanic:

1. Adjust the choke?
2. Rese' the float level?
3. Adjust the idle speed only?
4. Adjust mixture screws leaner?
5. Adjust mixture screws richer?
6. Adjust the CEC valve?

Worked up a sweat trying to figure out the answers? Check here to find out if you're right

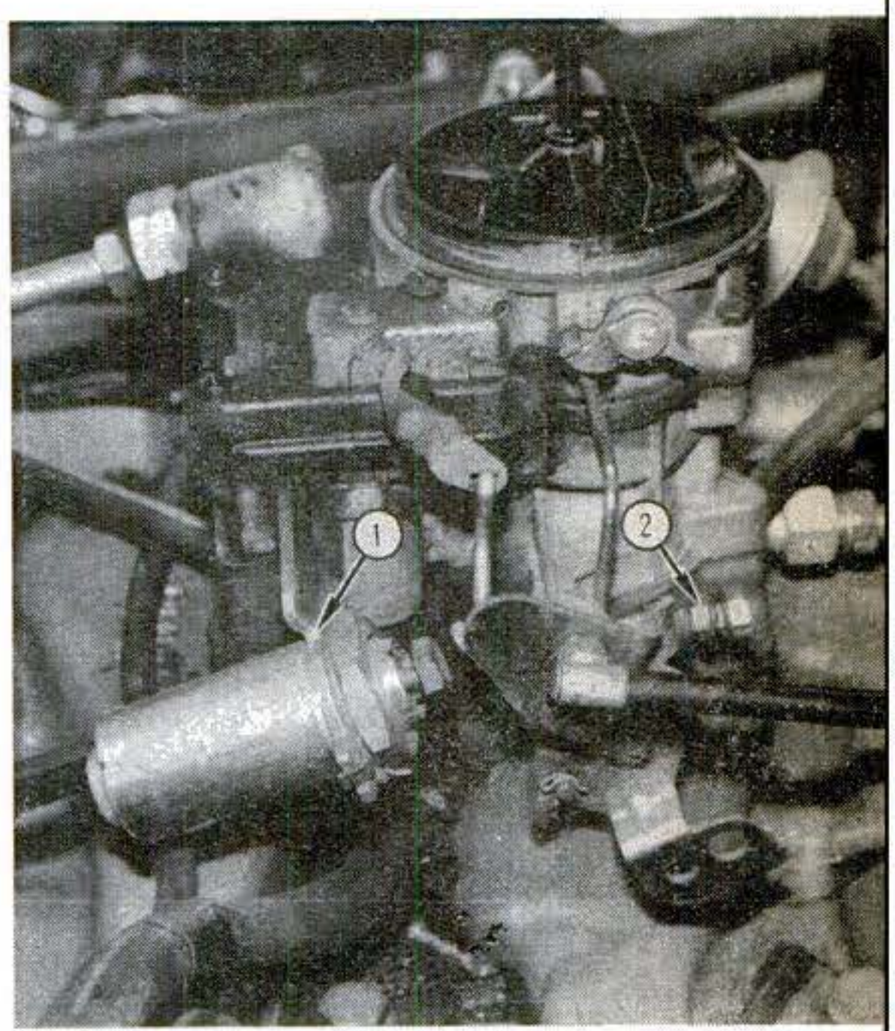
1 Remember that small cylinder you weren't interested in? The one on the side of the carb with a wire attached to it? It's an anti-dieseling solenoid, sometimes called a throttle-stop solenoid. When the ignition is switched on, the solenoid stem extends and holds the throttle in the curb-idle position so the throttle-stop screw is not touching the linkage.

You should have set the curb-idle on the solenoid, either by turning the stem, turning the whole solenoid, or adjusting the bracket (depending on what kind of car you have). A service manual for your car will give you exact instructions.

The throttle-stop screw should be used only for setting the low-speed idle with the solenoid deactivated. To deactivate the solenoid, disconnect the wire attached to it. Now the plunger won't extend when the ignition is switched on. The engine should be at operating temperature before adjusting the idle.

Cars with an anti-dieseling solenoid have two idle-speed specifications, one with the solenoid activated (plunger extended), and the other with it deactivated (plunger retracted).

Dieseling on emission-controlled engines is caused mainly by their higher idle speeds. The solenoid controls this. When the ignition is turned off, the stem retracts, allowing the throttle to move toward the closed position; this lets in less air so engine won't keep running.



Anti-dieseling solenoid (1, above) is adjusted by turning the head of its stem. Throttle-stop screw (2) is used only for setting low-speed idle. Specs for idle setting are usually indicated with two numbers separated by a slash. The higher number is used to set the idle with the solenoid activated.

2 Your friend's friend adjusted the idle at the wrong place. That's not an anti-dieseling solenoid on your friend's car. It's a combination-emission-control (CEC) valve. How do you know? Because of the vacuum hoses attached to it. An anti-dieseling solenoid doesn't have any vacuum hoses attached to it, just an electrical wire.

Also there's the partially painted-over decal. If you could have seen all the words, they would have read, "CAUTION: Never use to set idle. See manual for adjustments."

Although the curb-idle of an engine with an anti-dieseling solenoid should be set on the solenoid, the curb-idle of any engine with a CEC valve should be adjusted with a separate throttle-stop screw, not on the CEC valve.

When the CEC valve is electrically energized, it allows vacuum-spark advance, and at the same time increases the amount of throt-

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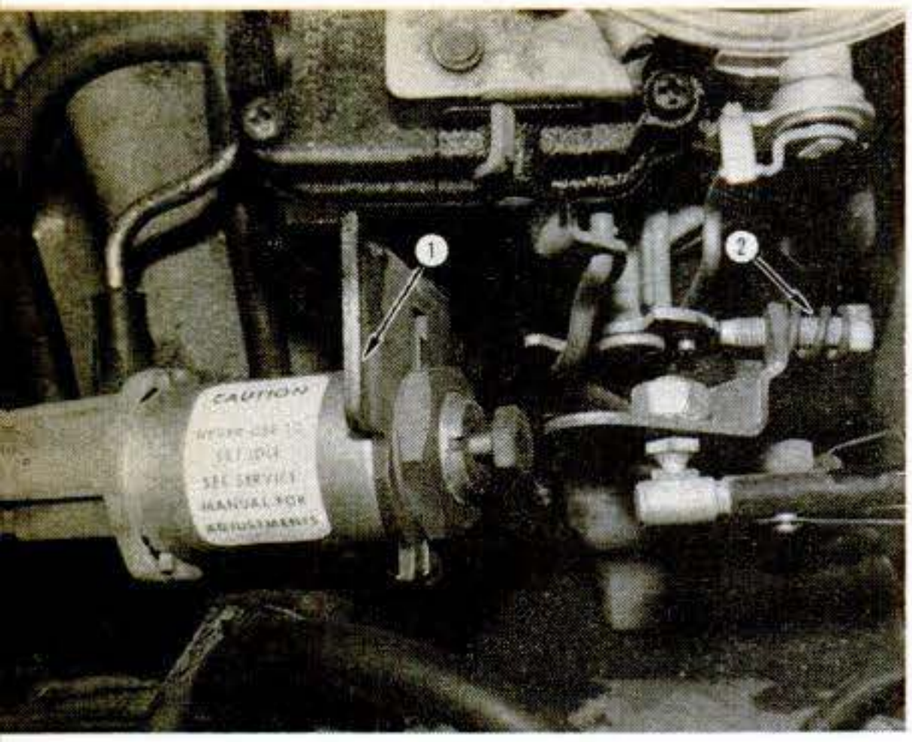
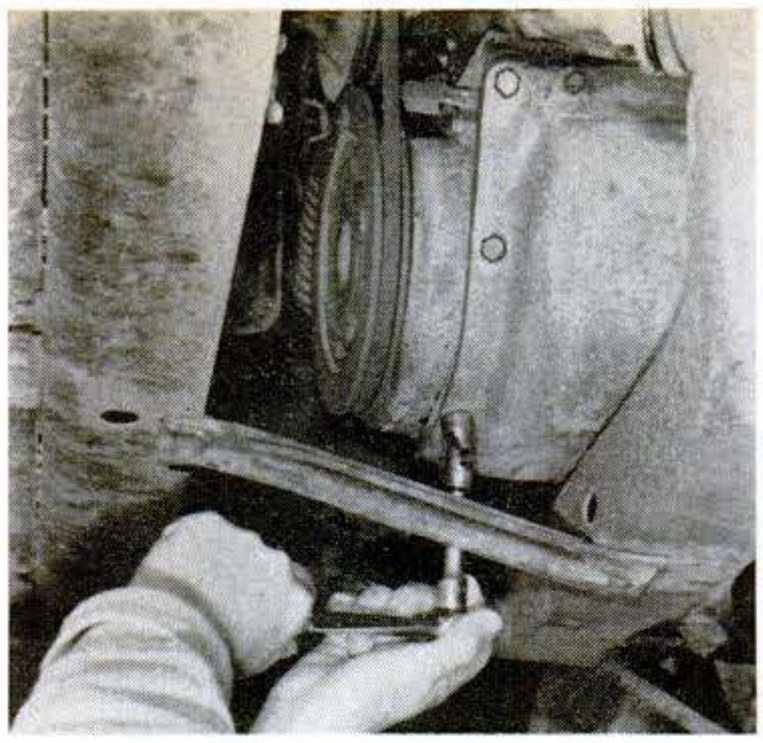


CEC valve (1) has vacuum hoses connected to it, plus an electrical wire. It should never be used to set the idle, as the label clearly warns. Idle speed should be set with the throttle-stop screw (2) in accordance with service-manual instructions. To prevent maladjustments, never paint over the warning label.



Oil-pan bolts should always be tight to provide an air-tight crankcase, which allows the PCV system to work properly, as well as to prevent oil leaks. It's possible for the bolts to work loose during use over many thousands of miles, especially if they were not tightened properly to begin with.

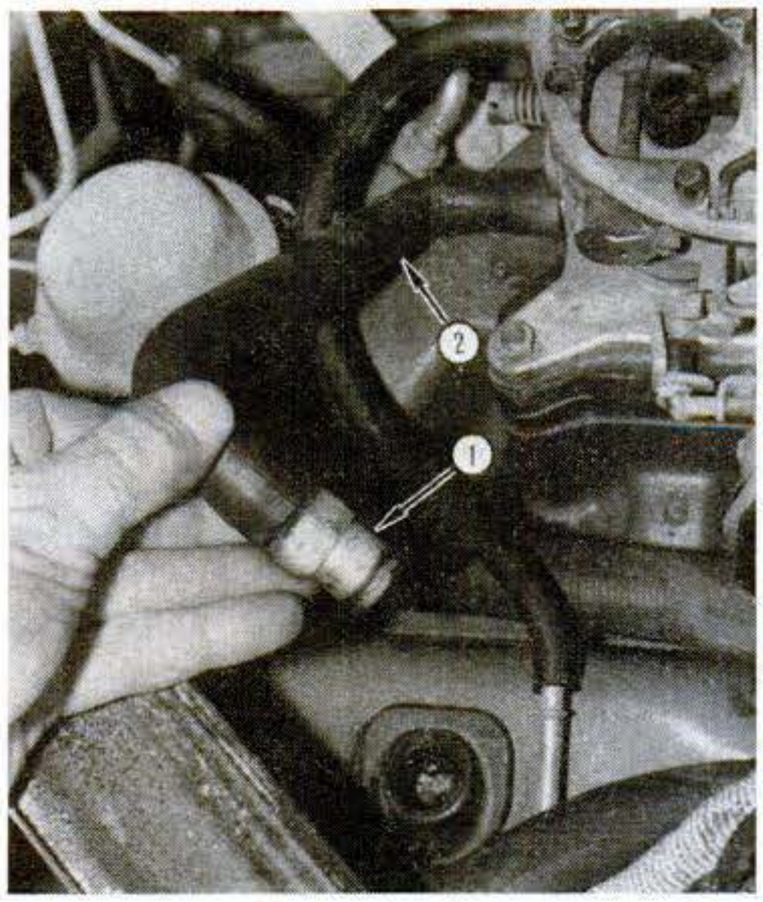
tle opening when your foot is off the gas pedal. The valve is energized in high gear only, on both automatic and manual three-speed transmissions. Some four-speed manual transmissions energize the valve in third and fourth.

On some automatic-transmission cars the CEC valve is activated in reverse gear (increasing the idle speed) because the switch that turns on the CEC valve operates from hydraulic pressure, and the same passages in the transmission are under pressure in reverse as in high.

When you drive the car, you don't notice anything different until you take your foot off the gas in high gear. And then there will be a little less engine braking on deceleration than you would normally expect. But if somebody has adjusted the idle speed with the CEC valve, over-extending the plunger (which is what happened here), you'll get no engine braking at all. And at low speeds in high gear the car will want to keep on going by itself.

3 The oil-pan screws probably need tightening, to stop a vacuum leak at the oil-pan gasket. On a high mileage car, this is a common cause of low crankcase vacuum—the oil-pan screws have worked loose. A fuel-pump gasket, front-cover gasket, valley-cover gasket, intake-manifold end seal, or a crankshaft seal could also cause the problem. But it's very unlikely.

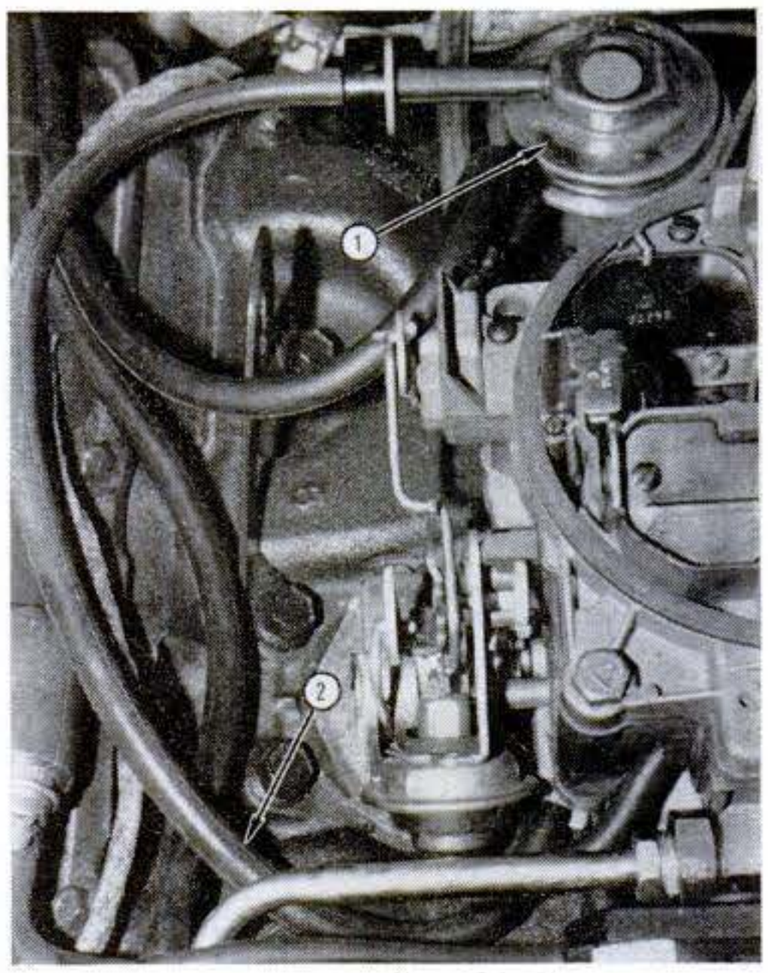
4 The vacuum hose between the PCV valve and the manifold is probably deteriorated inside from long use and full of flaking hose and carbon. This material dried up while the engine was torn down, then slowly flaked off after the engine was running again. A new hose will solve your problem. When buying a hose, PCV valve, or any other component, make sure it's the correct size and model.



PCV valve (1) may be in fine shape. But that doesn't mean the crankcase ventilation system is working at full capacity. Damaged PCV hose (2) can also stop the PCV system from doing its job (preventing blow-by fumes from reaching the atmosphere, directing them instead to the carburetor).

5 The exhaust-gas-recirculation (EGR) valve in many cars is vacuum controlled. It's connected to a vacuum port above the throttle plate, so that vacuum is applied to the port only above idle. When the throttle is in the curb-idle position, the EGR valve does not receive vacuum and stays closed. If the EGR-valve hose were accidentally connected to manifold vacuum, the EGR would be open at idle, and the car would idle roughly.

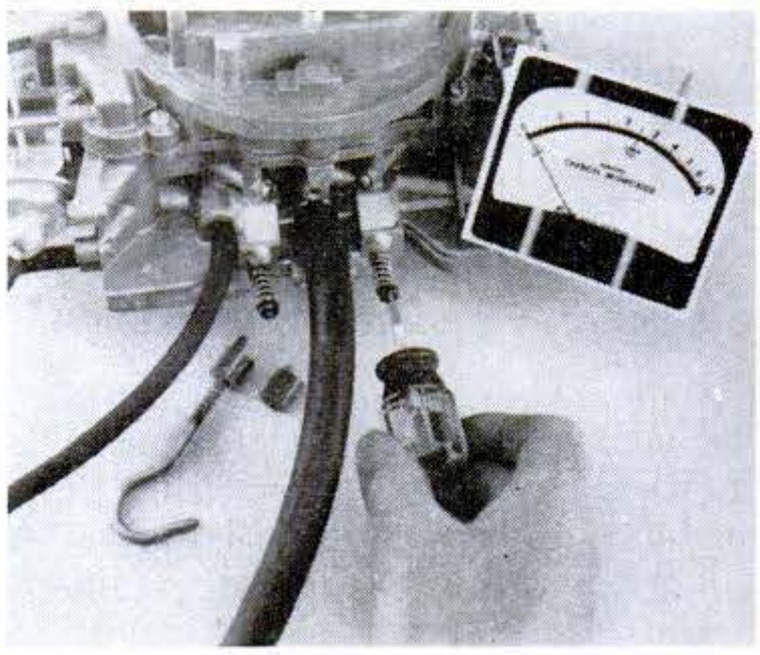
In an EGR system, metered amounts of exhaust gas are used to dilute the intake charge to reduce combustion temperatures for efficient emission control.



Looking under the hood of a new car, you may feel that you can't see anything because of the many vacuum hoses. They are all necessary, though. So be especially careful to hook each hose up at precisely the same place from which you unhooked it. EGR valve (1) and its connecting hose (2) look like this.

6 He adjusted the mixture screws leaner. A rich mixture (too much fuel) gives a smoother idle and produces more power, but increases the CO in the exhaust. A lean mixture (too much air) results in harmless carbon dioxide (CO_2). But if the mixture is too lean, the engine loses power and is rough at idle.

Adjusting idle on the lean side allows the car to pass state standards, but still keeps the mixture rich enough so the engine will run. Someday, someone may invent a means of achieving perfect fuel combustion, so an engine will produce nothing but CO_2 and still put out full power. PS



Adjusting idle-mixture screws affects carbon monoxide levels. Unless you're a pro with the proper equipment, leave the plastic caps on the screws.

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av. per cigarette, FTC Report Feb. '73.

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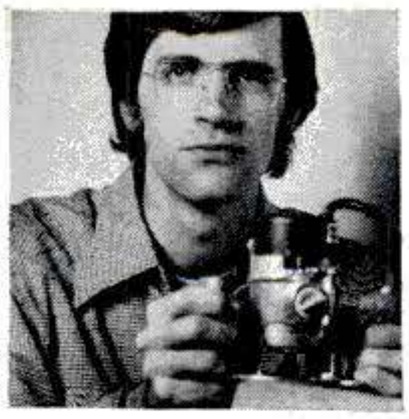


Shop Talk

News and views of tools and materials

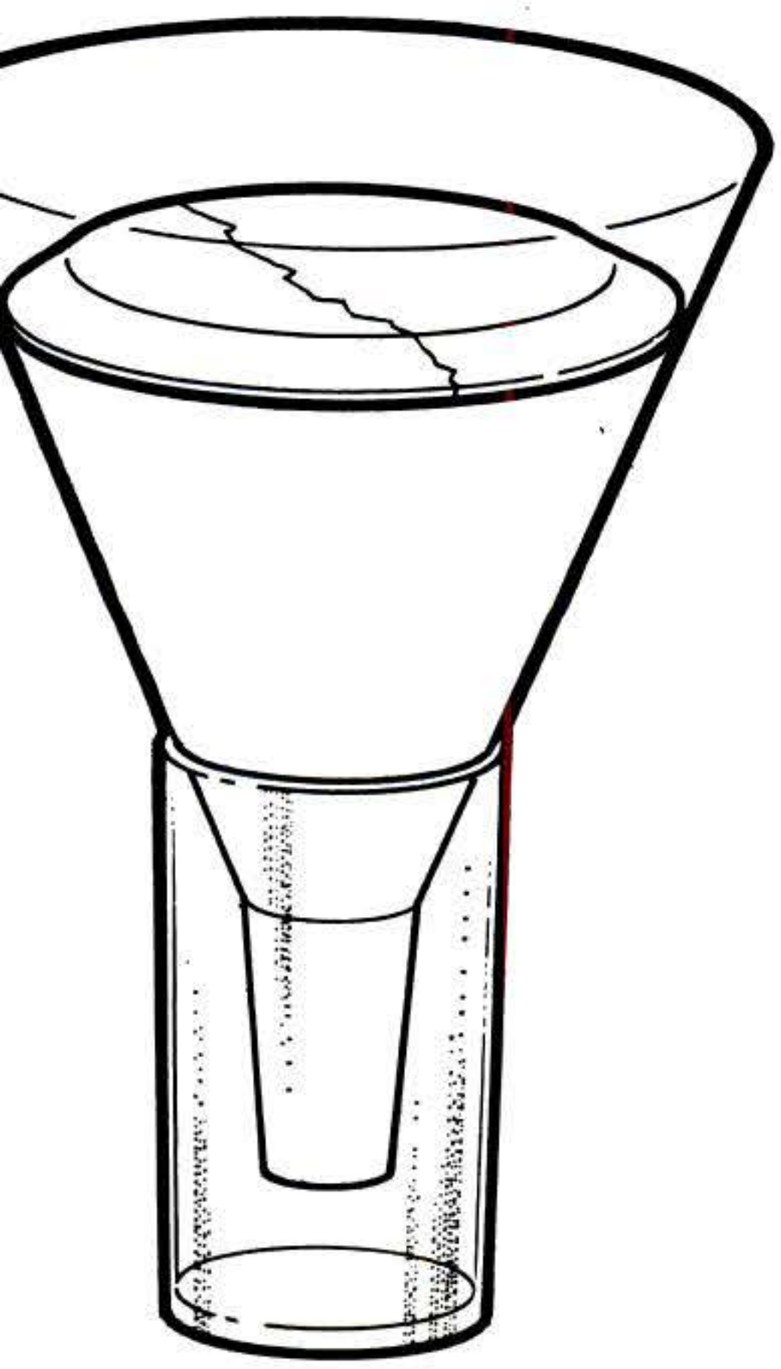
By A. J. HAND

A kit that helps you custom design your own addition

Thinking about a new room addition? The American Plywood Association has a kit that will help you get your thinking (and planning) straight. Their Add-A-Room Kit consists of three big worksheets and a pair of tissue-paper example sheets. Sheet one guides you in your initial research—local zoning and building codes, etc. It also explains how to make the most of the other two sheets. Sheet two gives you some examples of various roof and wall plans for one- and two-story houses. Sheet three is full of construction details you'll need to do your planning. Foundations, connections between old and new construction, eaves, trim, wall assemblies, and other details are covered. The tissue example sheets help you make your own plans—including the floor plan and elevations from three sides. The kits are available for $1 each from the American Plywood Association, 1119 A St., Tacoma, Wash. 98401. Ask for form W605 when ordering.

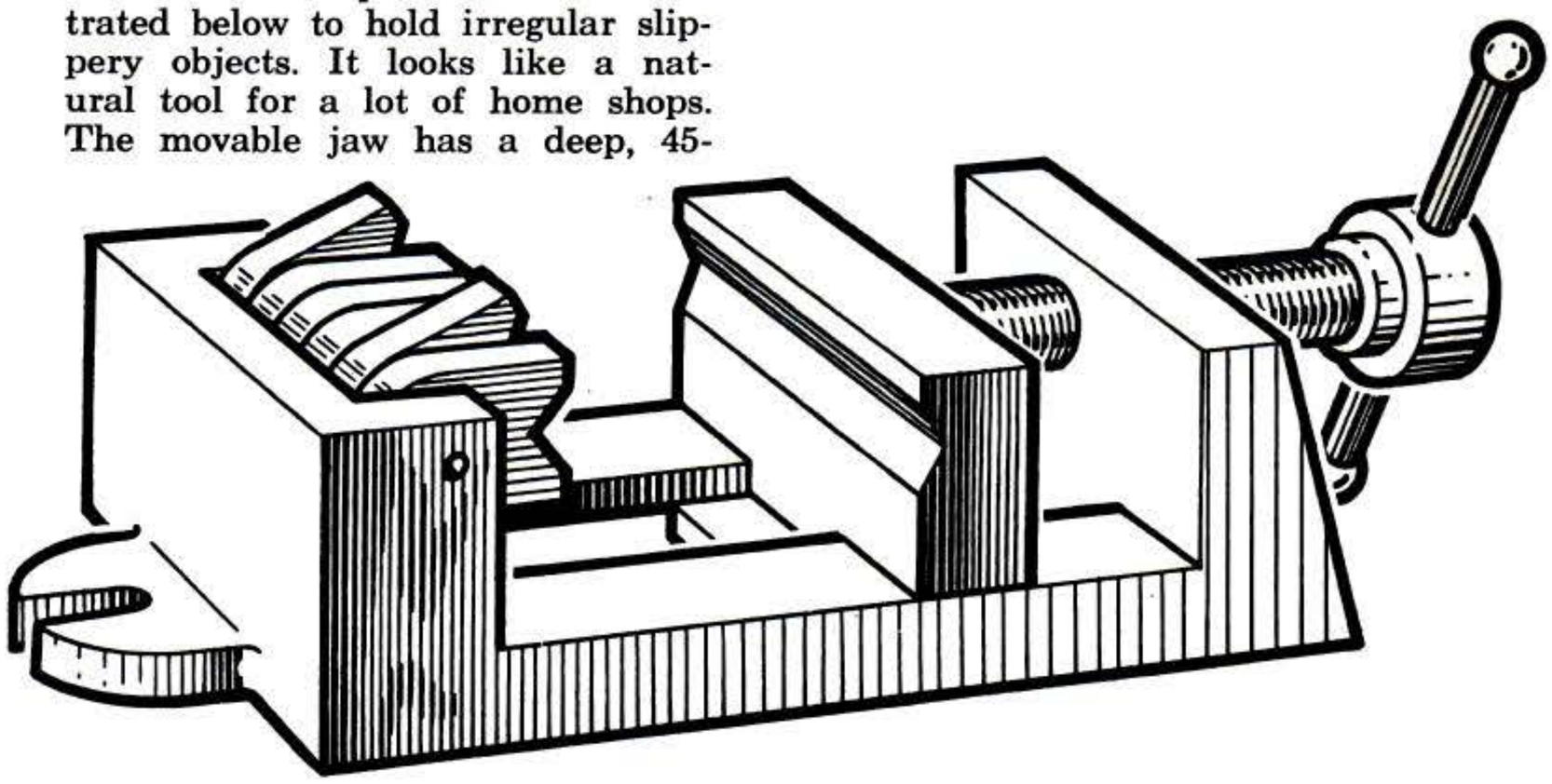
Gluing in the round

Ever have trouble holding the parts of a round object together while a glue job sets? PS reader Daniel O'Connell, of Attleboro, Mass., solves the problem with a funnel, as shown in the sketch below. To use the funnel trick, hold the glued pieces of the object in position on one hand, while you lower the funnel over the work. Press firmly and turn the funnel upright. Stand it in a glass or jar. Gravity does the rest until the glue dries.



Getting a grip on things

NASA developed the vise illustrated below to hold irregular slippery objects. It looks like a natural tool for a lot of home shops. The movable jaw has a deep, 45-degree notch across its face. The nonmovable jaw has a face made up of a series of notched segments, each one free to pivot through a short arc. Clamp an object in the vise and the notched segments move into positions that accommodate surface irregularities. The result is a good grip. Where can you get the vise? Right now you can't, but it shouldn't be much work to make your own from a standard drill-press vise.



The ultimate bike-repair manual

Last month in my article on tuning 10-speed bikes I mentioned an outstanding new bike repair manual by Clarence Coles and Harold Glenn. Since then, I've received a copy of the new two-volume manual put out by the Schwinn Bicycle Co. Though it's produced by Schwinn it isn't limited to Schwinn products. Its 956 pages cover just about every part you'll ever find on a range of pedal-powered vehicles that runs from unicycles, through all kinds of bikes, and on to adult tricycles. If you'd like a copy of the hard-cover manual, send $20 to Schwinn Bicycle Co., Sales Prom. Dept., 1856 N. Kostner Ave., Chicago, Ill. 60639.

things to write for

- A pamphlet on making fishing lures from recycled materials such as old balloons and pop tops from beverage cans. It's 25 cents from Outrigger, Box 20803, St. Petersburg, Fla. 33702.
- A pamphlet outlining precautions you can take to protect your boat against thieves. It's yours free from the State Farm Fire and Casualty Co., 112 E. Washington St., Bloomington, Ill. 61701.
- A 187-page catalog of tools, hardware, and specialty items at bargain prices. It's $1 from U.S. General Supply Co., 100 General Place, Jericho, N.Y. 11735.
- A catalog of tools and repair items—things like stripping and crimping tools, impact screwdrivers, snap rings, and solderless terminals. Free from Vaco Products Co., 510 N. Dearborn St., Chicago, Ill. 60610. Ask for catalog SD-168.

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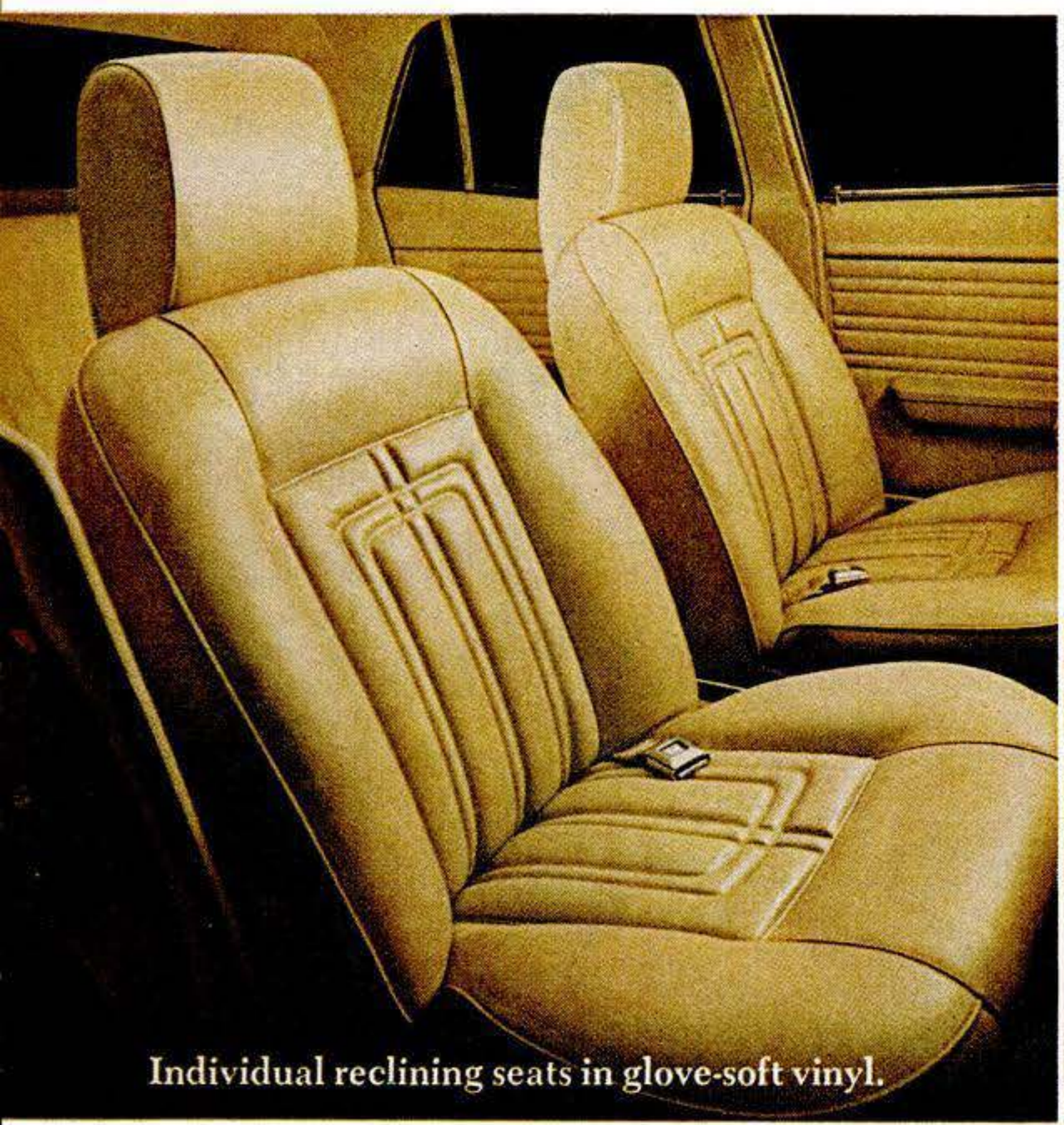
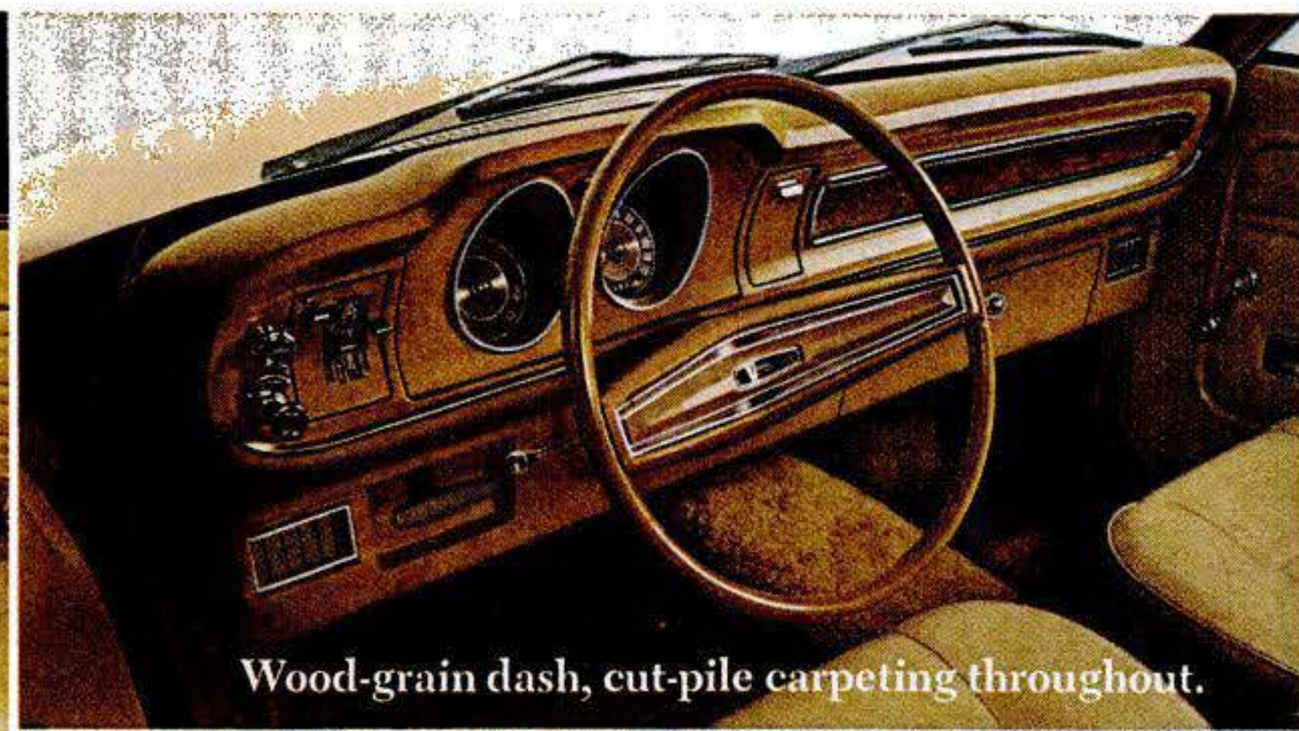
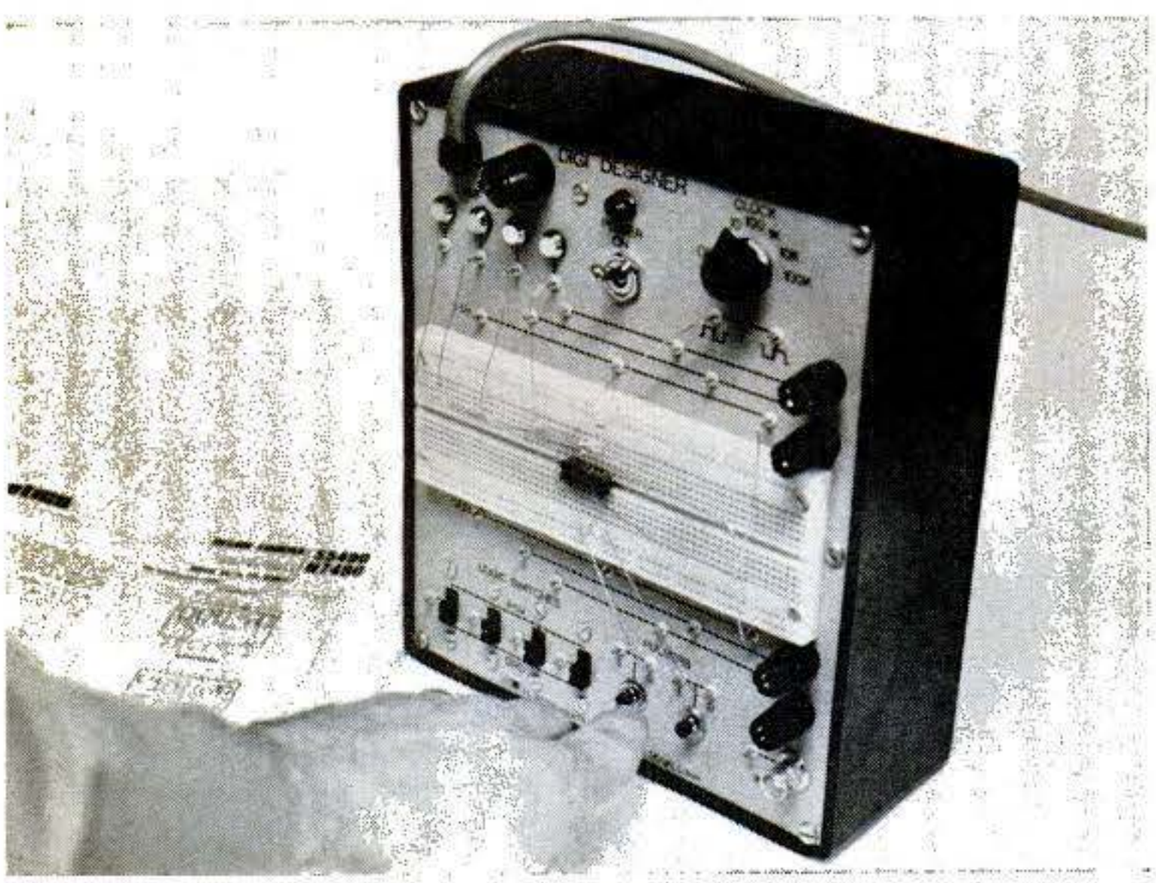
You'd expect this kind of luxury in $6,500 European cars.


Individual reclining seats in glove-soft vinyl.

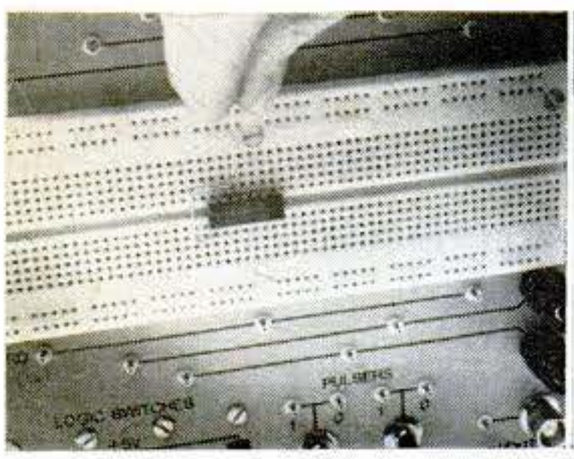

Wood-grain dash, cut-pile carpeting throughout.

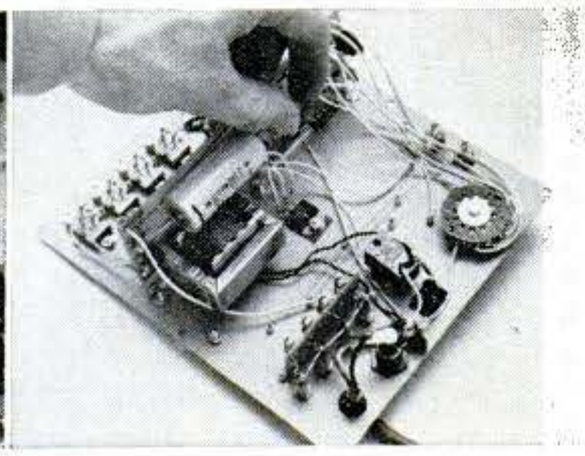
Steel-belted radial-ply tires.

Grained vinyl roof.



Built-in test functions speed up test-circuit checkout.


Perforated circuit board has miniature connectors at each hole. Connection is reliable with no solder needed.


Kit form is easy to wire. Components mount on individual PC boards. Power supply is initially set for five volts.

PERSONAL-USE REPORT

Plug-In Helper for Quick Circuit Designs

Whether you're a hard-core circuit designer or just a tinkerer, you're always bucking one problem when you breadboard a circuit—it takes time to build. And, since it's just a breadboard, you can end up with a rat's nest of poor solder connections, shorts, and a maze of interconnections between test circuit and test equipment. Now there's a quick and simple way out—the Digi-Designer. It needs no soldering, and many test pieces you'd ordinarily use for digital circuitry are built in.

Want to try your hand at a circuit? Plug the ICs directly into the perforated board. The pins mate with miniature internal connectors running in vertical columns down the board. To connect to an individual pin, you simply plug a piece of 22-gauge solid wire into one of the remaining holes in a particular row. Where you connect the opposite end of the wire depends on your circuit. It may go to another pin of an IC or it may go to one of the test circuits built into the Digi-Designer.

The unit has a clock pulse generator (1, 10, 100, 1k, 10k, and 100kHz), regulated five-volt power supply, two bounceless pushbuttons, four slide switches, four logic-indicator lights. You can also plug into banana plugs or a BNC connector for off-board connections.

Digi-Designer makes fast work of any breadboarding job and makes a handy tool for the electronics shop. It's $59.95 as a kit, $95 assembled, from EL Instruments, 61 First St., Derby, Conn. 06418.—*W. J. Hawkins.*

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But not in an American compact at $2,695.*

New comfort and luxury have come to the rugged, reliable Ford Maverick.

Our Luxury Decor Option gets you the luxuries shown at left, plus about 30 others, including steel-belted radial-ply tires. Tests show that the average driver can expect 40,000 miles of tread life under normal driving conditions.

Every 1973 Maverick comes with a refined suspension system, thicker seats, European-type arm rests, carpeting, plush door padding. The ride is quiet.

Test drive a Maverick at your Ford Dealers. And see how luxurious a rugged, reliable compact can be.

FORD MAVERICK

FORD DIVISION Ford

Car shown: $2,695 sticker price. Dealer preparation, destination charges, title fees and taxes extra.

Better idea for safety . . . buckle up.

Turn ignition on, activating receiver; push button on TMX. Now you can start your car. Turn off ignition–receiver automatically resets. Key switch on receiver allows parking attendant to operate car.

TMX: It Theftproofs Your Car Electronically

Ever try connecting a "secret" ignition switch in your car to foil the thieves? The wiring is easy–it's location that's the problem. Behind the air duct and inside the car radio it may elude a crook, but it has drawbacks when *you* want to start your car.

TMX's switch is based on the out-of-sight idea, but with a twist; you hide it in your pocket.

Want to start your car? Push the button on this miniature radio transmitter. A pulse/tone coded signal, assigned only to you, is transmitted to a black-box receiver placed inconspicuously in your car.

The 200-650 mHz signal is received, decoded, and, if correct, used to deactivate the protection circuit. The result–your car starts when you turn the key. Without the signal, the engine would just grind.

A key-switch on the receiver lets you deactivate the system, allowing your car to start normally for parking attendants or garage mechanics.

Just three internal connections to your car make installation simple and invisible. Possible code combinations are too numerous to make "cracking" practical, and one-button operation makes everyday use as close to convenient as I've seen.

The TMX Data Code/2000 is $89.95 from TMX Inc., 666 Fifth Ave., New York, N.Y., 10022. Extra transmitters for second drivers are available.–*W. J. Hawkins*

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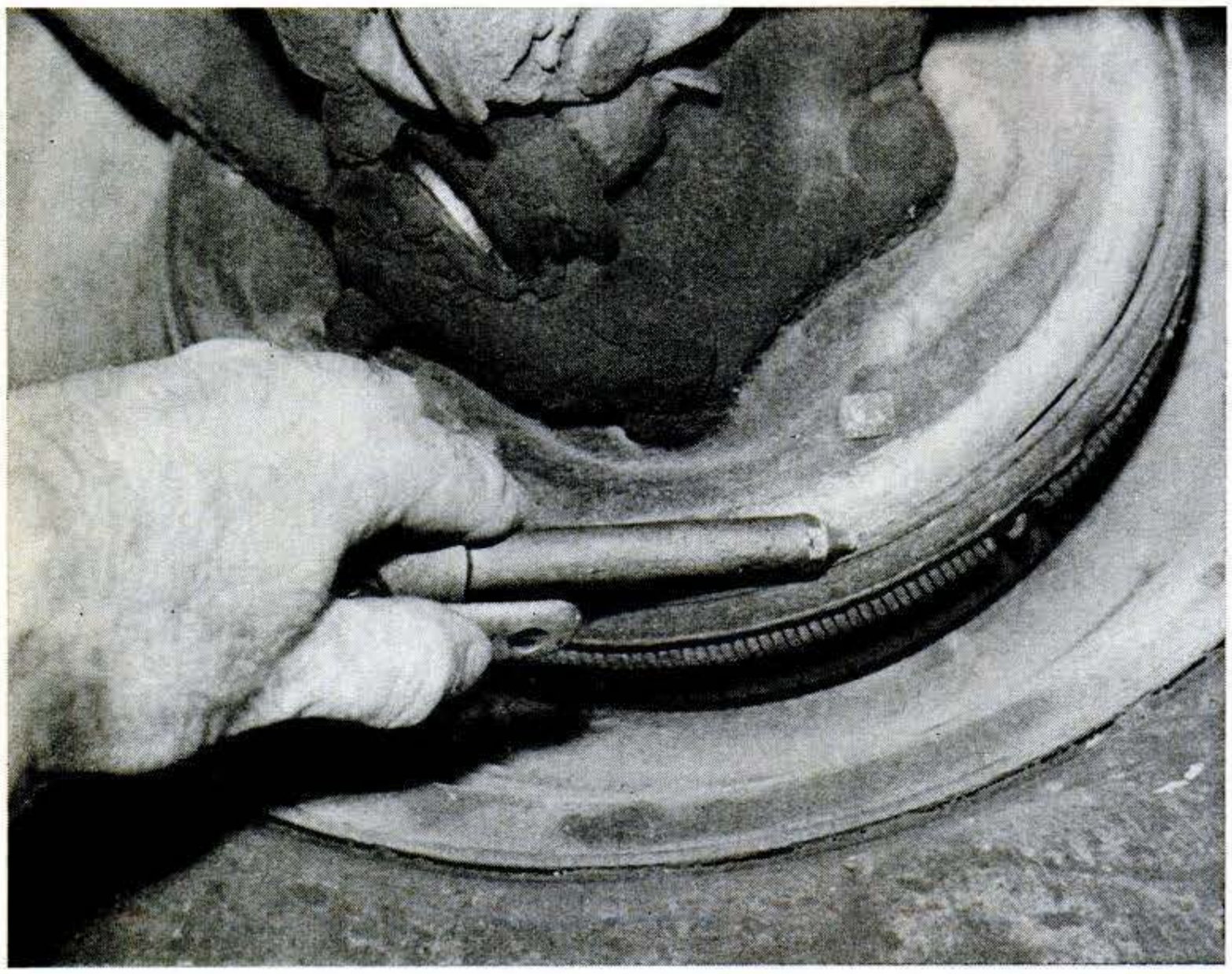
Taking Care of Your Car

By RAY HILL

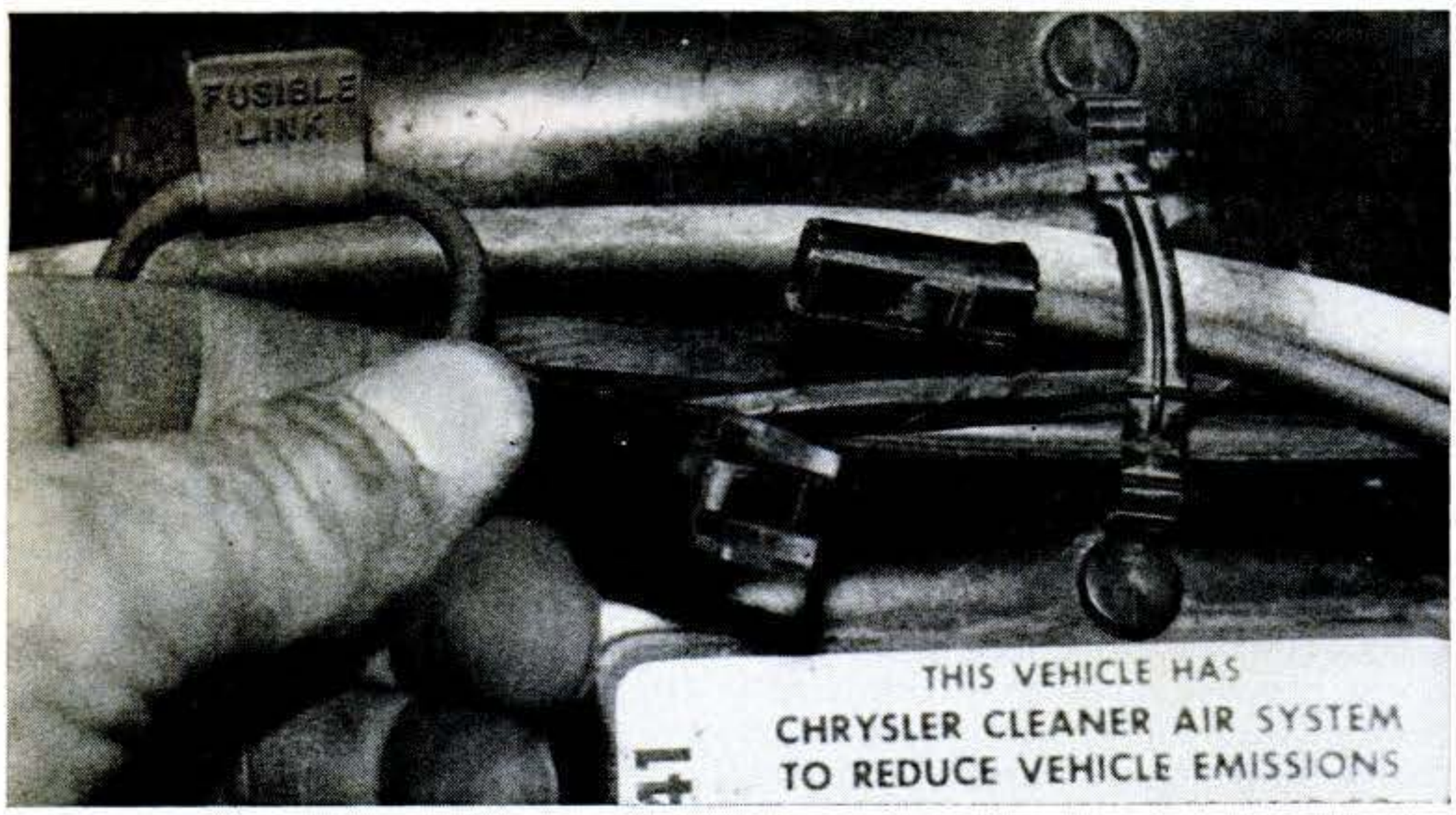
Good hints others have used

Got a car tip? We pay $25 for each one accepted. Send it to Car Care, Popular Science, 355 Lexington Ave., New York, N.Y. 10017. None are returnable.



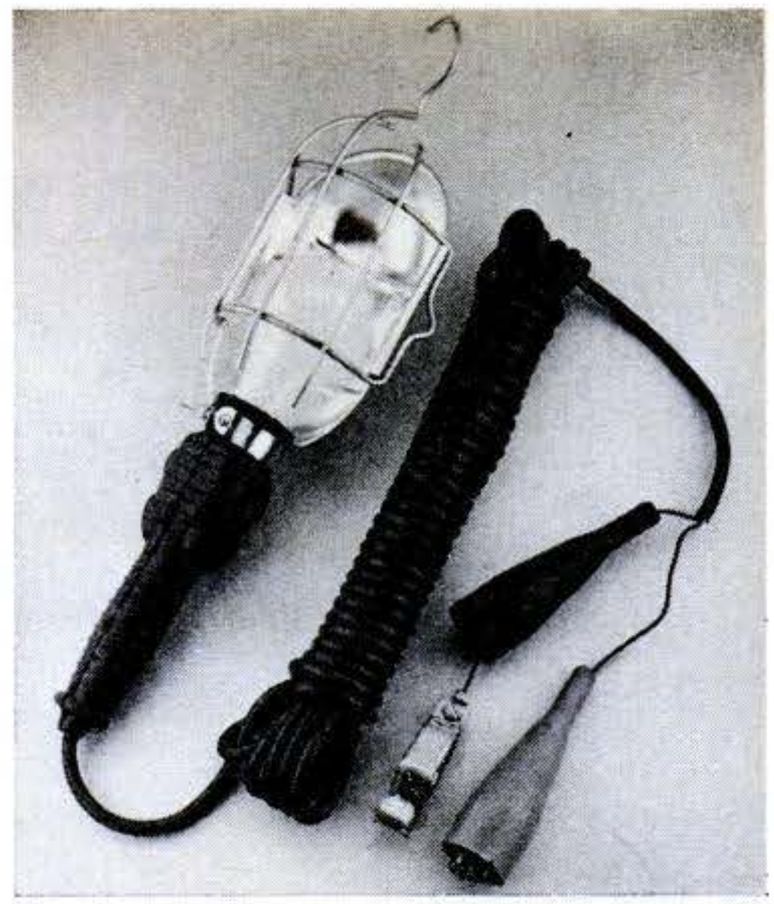
Brakes squeak when brake pedal is depressed

An annoying squeal from drum brakes can be caused by dust between the lining and the drum. The dust can be removed without disassembling the brakes by blowing compressed air into the brake drum as shown.



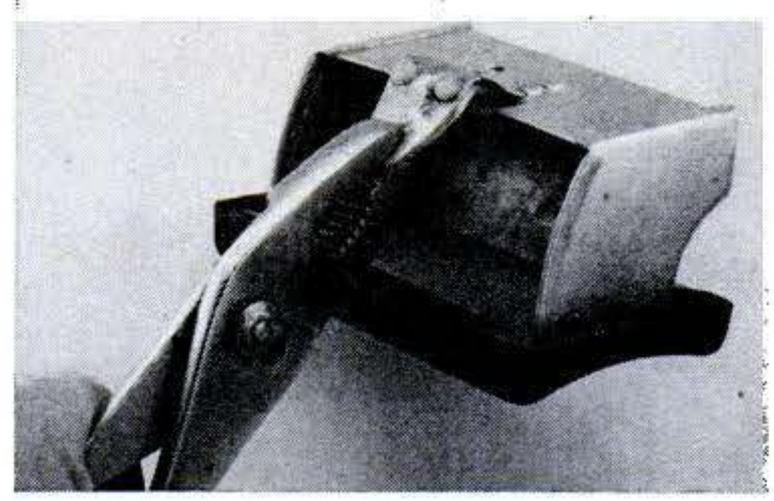
Need to disable the battery for service work?

On cars with a fusible link, disconnecting this link is the fastest and most reliable way of disabling the battery. Only when servicing the starter or starter cable should you disconnect at the battery itself.



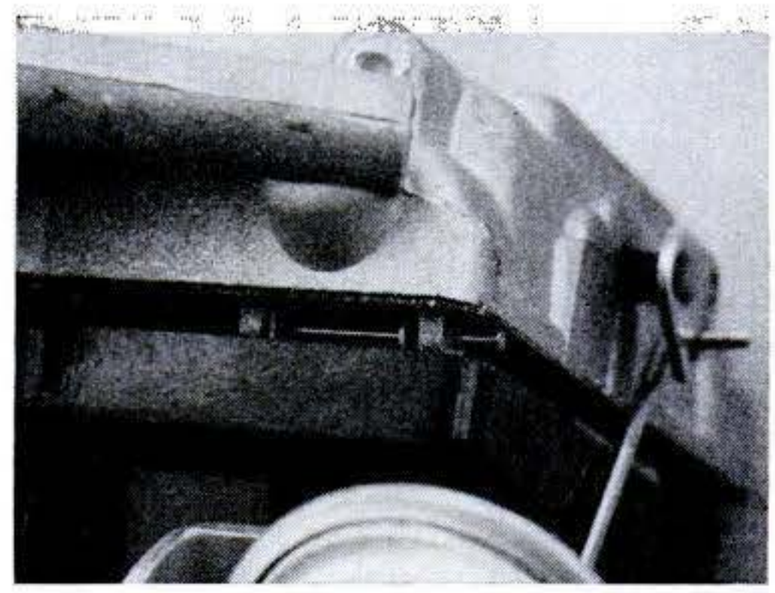
Easily made trouble light

You can quickly convert one of your shop lights into an emergency light to carry and use in your car. Cut off the plug and attach two alligator clips in its place, as shown. Then replace the bulb with a 12-volt one. Now the light can be powered by your car battery.



Loose ashtray

A loose car ashtray that occasionally dumps its contents on the car floor and on you can be irritating. To solve the problem, remove the ashtray and with pliers, bend up the snuffer about ¼ inch from its original position. Then reinsert the ashtray—no more dumping.



Carburetor repair

When installing the float-bowl cover on a Carter four-barrel carb, make sure that the float-lever pins are centered in their supports. If they aren't, they may be trapped between the gasket surfaces, and when the cover screws are tightened, the bowl will crack.

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HEAVEN ONLY KNOWS HOW OFTEN YOU SHOULD CHANGE YOUR OIL.

First it was every thousand miles. Then somebody said every fifteen hundred. Then somebody else told you six thousand. It depends on who you ask. And it's enough to confuse anybody.

There's no absolute rule to how often you should change your crankcase oil. The time of year and climate have a lot to do with it. But don't leave it to heaven. There's a lot at stake, and a lot to know.

Your driving habits can be a factor. Oil should be changed more often under conditions of extensive idling, trailer pulling, driving in dusty conditions, and short trip operation at low temperatures.

So even though we've been in the gasoline and oil business for so many years, even we can't give you a simple answer.

We do recommend an oil change at least every 3000 miles or 3 months; but you should never exceed the automobile manufacturer's recommendation.

You should also read your owner's manual very carefully. Especially the fine print, which might reveal some exceptions according to your climate and driving practices.

If you still can't determine how often to change your oil, bring the manual and the car to your dealer. He changes a lot of oil in your area for people who probably have the same driving habits and type of automobile as yours.

Of course, we hope the dealer you bring your car to is a Gulf dealer. He'd be glad to help you learn about that, and anything else you'll like to know about your automobile.

You can also send your questions direct to Gulf Consumer Information, Box 1519-J, Houston, Texas 77001.

You see, we'd like you to learn all you want to know about your car. And our products. That way we can keep you on the road. And us, too.

GET TO KNOW GULF AND YOU'LL GET TO KNOW YOUR CAR.

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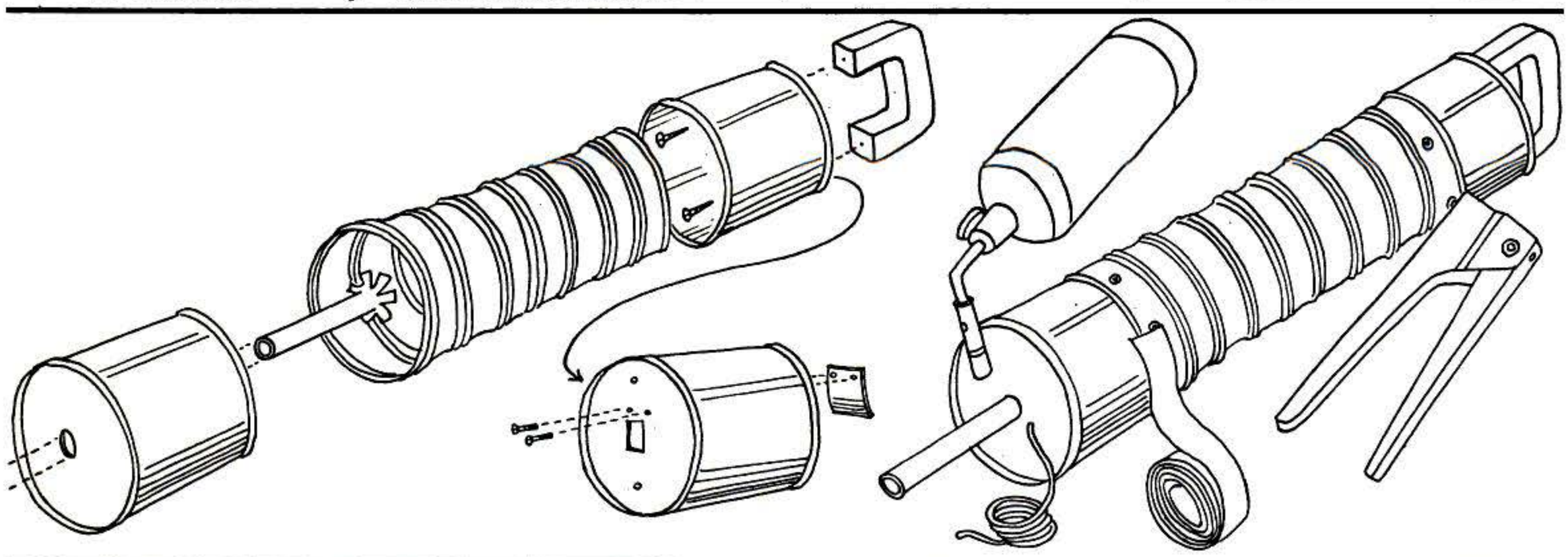
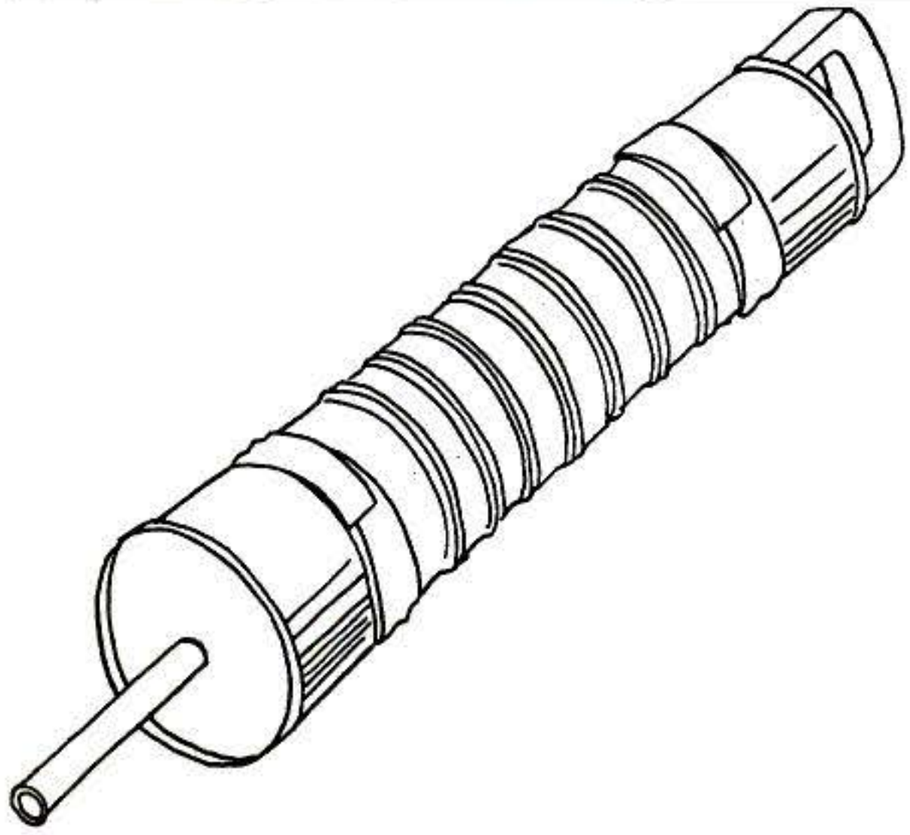
Wordless Workshop

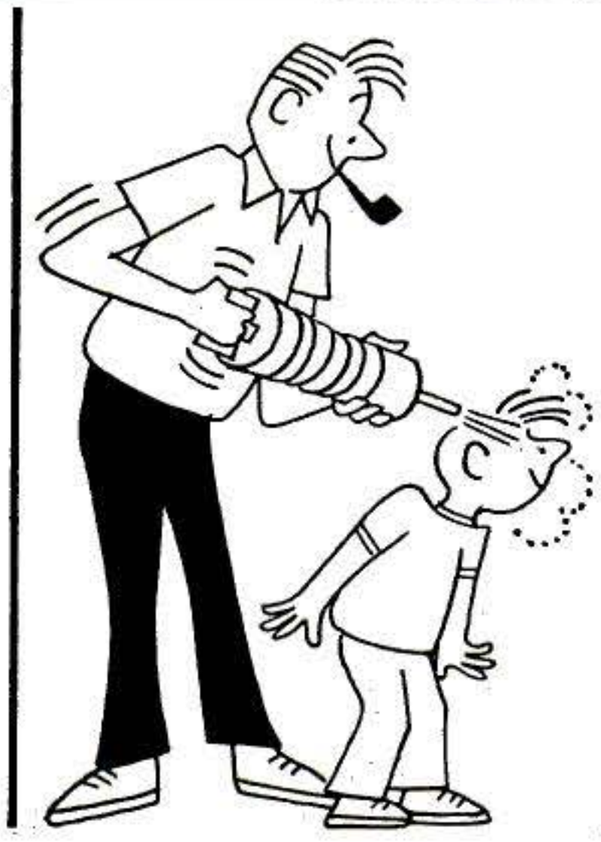
By ROY DOTY

Idea by GEORGE H. WENTWORTH

$25 to Mr. Wentworth, Decatur, Ill. Send your idea to Wordless, Popular Science, 355 Lexington Ave., N.Y., N.Y. 10017. Only purchased ideas are acknowledged.







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Sears New Split-System air conditioning is so quiet you can hardly tell it's working.

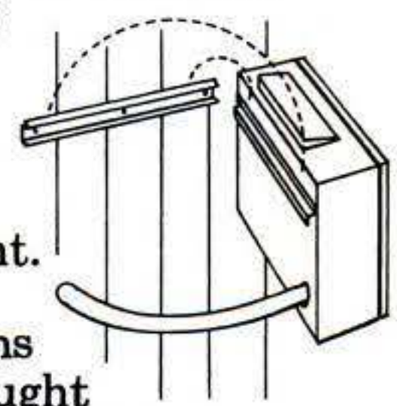
Until you step outside.

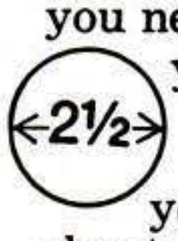
Our Split-System air conditioner is a case of two halves of an air conditioner being better than a whole one.

The quiet half that does the cooling stays inside on the wall (not in the window).

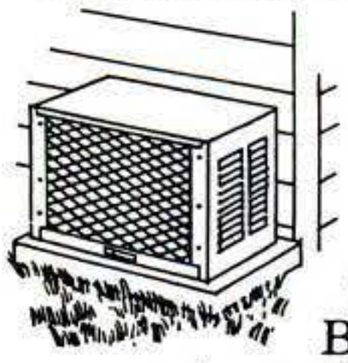
While the half that does the heavy work goes outside. Out of sight and out of hearing—up to nineteen quiet feet away. (And since a 2½ inch hole through the wall for the tubing is all that's needed to connect both units, you can install it yourself.)

Sears Split-System is one room air conditioner that doesn't need a window to work. So you can put it practically anywhere in the house—from the attic to the basement. You can air condition rooms you never thought you could cool before.





The Sears Split-System air conditioner keeps you cool while keeping quiet about it. And it's available in 6,000, 10,500 and 15,500 BTU models. Split System. A whole new kind of cool from Sears, Roebuck and Co. Because who knows more about air conditioning than your Sears Air Men.



Sears AIR MEN

Pick up a copy of our easy-to-follow Installation Booklet in the Central Air Conditioning Dept. of your local Sears store.

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Probably yours, too Test drive it You'll like it!

Rislone National Championship Racing Jacket only $7.95 prepaid. Durable nylon-cotton. Rislone yellow with red, black racing stripes. S, M, L, XL. Send check or money order to: Rislone National Champion Jacket, P.O. Box 457, Bonner Springs, Kansas 66012.

THE SHALER CO.
Waupun, Wisconsin 53963
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World's Tallest in Toronto

[Continued from page 66]

steel and 700 tons of structural steel.

Some 62,000 cubic yards of shale were excavated for the foundation. And, from the bedrock on which the tower rests to the tip of the TV antenna, the height is 1834 feet. The base of the tower is 167 feet wide.

Keeping walls plumb. That's one big problem. Three methods are being employed by the builders to assure that the facade is aligned. They're using optical plumbs, plumb bobs, and measurements from outside with transits.

Aside from the ground-level rotunda, the only usable space in the tower will be a Sky Pod at the 1100-foot level. This 400-foot-high capsule will house a spectacular restaurant, broadcasting studios, and observation decks in its six stories. From this point, visitors will be able to see all the way to Lake Ontario.

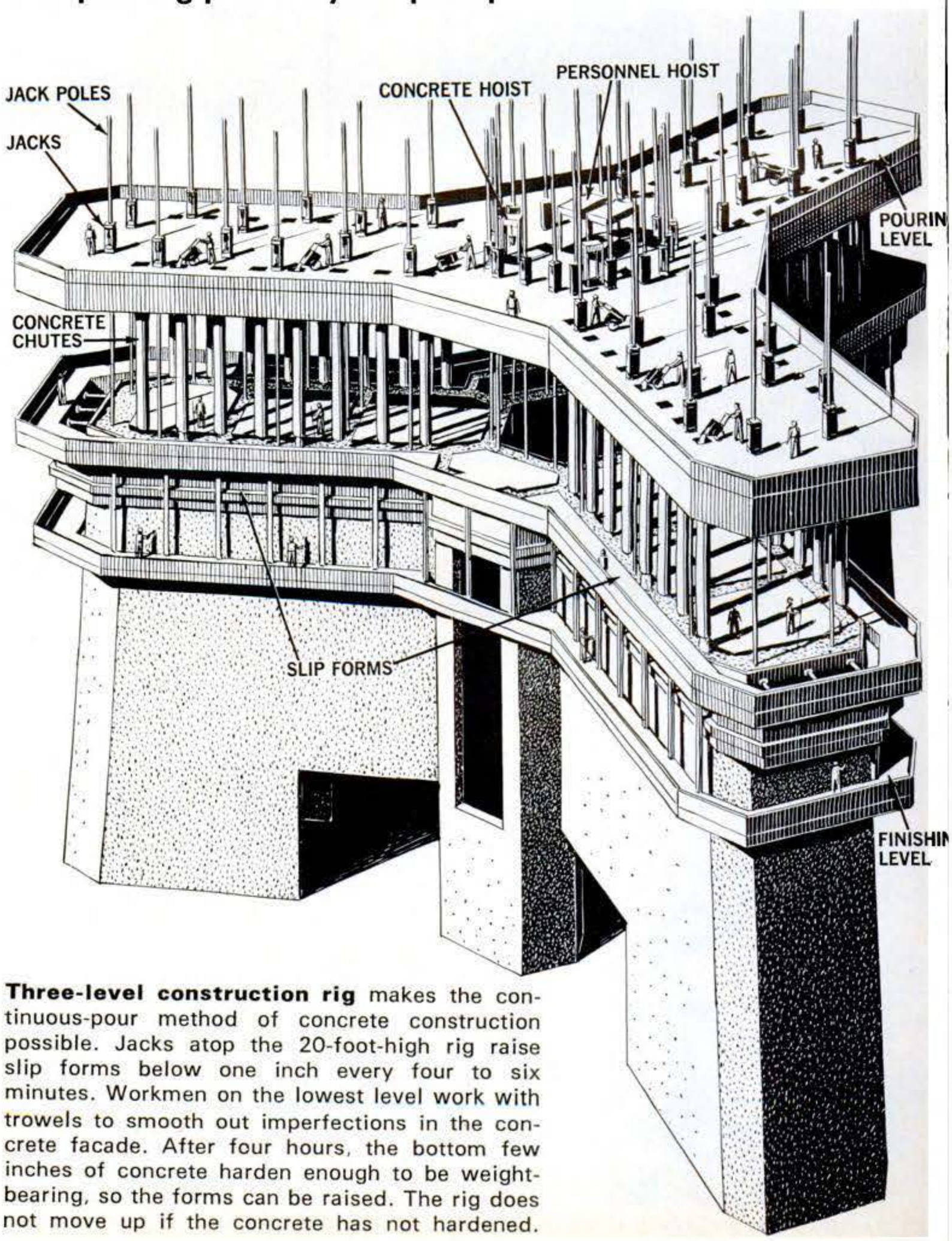
Beating everything all hollow. Apart from the Sky Pod, the tower is a hollow core. Inside it, platforms will be spotted every 200 feet to accommodate maintenance workers. And cables and plumbing for the building will also run inside the core.

Engineers have tested models of the CN Tower in a wind tunnel at the University of Western Ontario. Besides being designed to withstand very high winds, the tower is built to resist damage from ice, lightning, and earth tremors.

After the concrete work is completed in November, there will be no further outside work at the top. But next April workmen will start to erect the 220-ton antenna.

Upper-level facilities, including the restaurant, whose tables will revolve around the Sky Pod, are slated to open for Christmas. PS

Complex rig pulls skyscraper up



Three-level construction rig makes the continuous-pour method of concrete construction possible. Jacks atop the 20-foot-high rig raise slip forms below one inch every four to six minutes. Workmen on the lowest level work with trowels to smooth out imperfections in the concrete facade. After four hours, the bottom few inches of concrete harden enough to be weight-bearing, so the forms can be raised. The rig does not move up if the concrete has not hardened.

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The Multipurpose Cars

[Continued from page 55]

drive only. With automatic freewheeling hubs locked, you can engage or disengage the front axle while you are moving.

This system hasn't the full convenience of full-time four-wheel drive, but it costs $300 less than the Chevy and Jeep systems. It offers no low range, and no power takeoff.

The Scout is a modern design with an inside hood release that opens a front-hinged hood. The brake pedal is extra wide, for left-foot use. However, the factory-installed A/C system has an "add-on" appearance, and the instrument panel has no permanent air vents. The instrument-panel is about on a par with the Chevy Blazer's.

The interior is smaller, but has some special features. The rear seat folds up, flush against the back of the front seat. Access to the rear seat is through the right door. Only the right half of the front bench-seat back tilts forward. The release is a tiny lever hidden in the hinge area. It's hard to find, and almost impossible to use.

On the plus side, working on the Scout engine is simple and easy, even with A/C under the hood.

Jeep Wagoneer. Originally a '61 design, the Wagoneer now has the most advanced power train in its history—an AMC V8 with Chrysler's automatic transmission, and Borg-Warner's full-time four-wheel-drive system. As in the Blazer, it requires a minimum of skill.

Our test car also had power steering and power brakes. The steering gear is a variable-ratio unit by Saginaw. It's got lots of lost motion around the straight-ahead position, so half a turn has little effect, but if you crank it a bit more, you get a somewhat sharper turn than you probably intended.

The Wagoneer has a passenger car's interior, but the back seat can be folded up against the back of the front seat in less than a minute. The tailgate is like a regular wagon's—from inside, you drop the glass using a switch on the dash, or from the outside, by turning your key in the lock, then lower the tailgate after releasing it with a handle inside.

The spare wheel stores under the car, exposed to road dirt and risk of theft, but freeing the interior for maximum useful space.

Ride comfort is generally fair, but strong body roll on curves can upset passengers. Body roll also interacts with the suspension, producing roll-steer effects. Handling is only fair. Performance is surprisingly lively for such a heavy car, and the drum brakes held up quite well. Service accessibility is very good. PS

"No wedding. I'm celebrating the last payment."

"How I rewired my taillights with a plastic straw and Dow Corning Bathtub Caulk."

We knew our silicone rubber bathtub caulk was good for a lot more things than bathtubs, and when we heard how Larry Oswald of Sewickley, Pa., used it, our opinion was confirmed.

"When my taillights started getting dimmer and dimmer, I took them apart and found that the sockets, wires, everything, were all corroded.

"So I cleaned everything up, bought two new sockets, and decided this time that they weren't going to corrode.

"I had a tube of Dow Corning® Bathtub Caulk lying around the house, so I figured why not, and caulked up the sockets.

"Then I figured that if it'd work on the sockets, it'd work on the splices. I cut two small pieces off a plastic drinking straw, slid one over each set of wires to keep them from getting stuck together, tied the wires together, and then pumped them full of caulk.

"It's been six months now, and my taillights are still brighter than ever."

Next time you're faced with a plumbing leak, broken gasket, or almost any fix-it job around the house, get the Dow Corning Silicone Bathtub Caulk out of the bathroom and put it to work.

You'll find it in white and pastel decorator colors in the hardware or paint department of your favorite store. Look for Dow Corning Silicone Sealer in clear, black, or aluminum in tubes and cartridges, too.

Dow Corning Corporation, Dept. E-3102, Midland, Michigan 48640.

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Join your credit union. It's where you belong.

For more information write to your state's Credit Union League or Credit Union Nat. Assoc., Inc., P. O. Box 431, Madison, Wisc. 53701.

Easy-Apply Teflon Film

[Continued from page 101]

they did point up three plus factors of the Teflon film—easy-slide, anti-stick, easy to clean. Equally impressive was the easy-to-apply-anywhere characteristic of the material in film form.

More extensive tests were conducted in the shop where hard-use situations presented a picture of the material's durability *and* utility. I have always maintained that clean, well-waxed, tool-table surfaces provide extra safety as well as easier cuts. The Teflon film simply eliminates the cleaning and waxing chore.

It can be an overall application—say, on jigsaw and bandsaw tables—or it can be just a spot use on the rip fence and the insert of a table saw. The cost of the material (for price of sample, see box) can be a factor in determining how much of any particular area you will cover. An "out," where cost is prohibitive, is this fact—narrow strips placed about 4″ or 5″ apart running parallel to the saw blade on a table-saw surface can be as useful as overall coverage.

How you apply it. Don't try to precut the material to size; it's better to be a little generous to begin with. Peel off the backing paper and stick the Teflon on, then trim to size with a really sharp knife. On large surfaces with either type film, peel off the backing as you stick the stuff down. You can get into trouble if you allow tacky surfaces to come together; especially with the unmounted film.

Rub hard with a cloth as you peel off the backing. Watch for air bubbles. If you get one, pull back on the film and rub the bubble out to a free area. It's possible that you might capture an air bubble you'll find impossible to eliminate by rubbing. In that case, prick it with a pin and work the film down around the hole with your finger.

It's not wise, on a fairly large area (say, a jigsaw table) to try to remove the entire application in order to improve the job. You will surely ruin the sheet. It's better to work with the pinprick method or even a slit with a sharp knife. Best bet, especially with unsupported film, is to be very careful right off—avoid air bubbles and pull-backs.

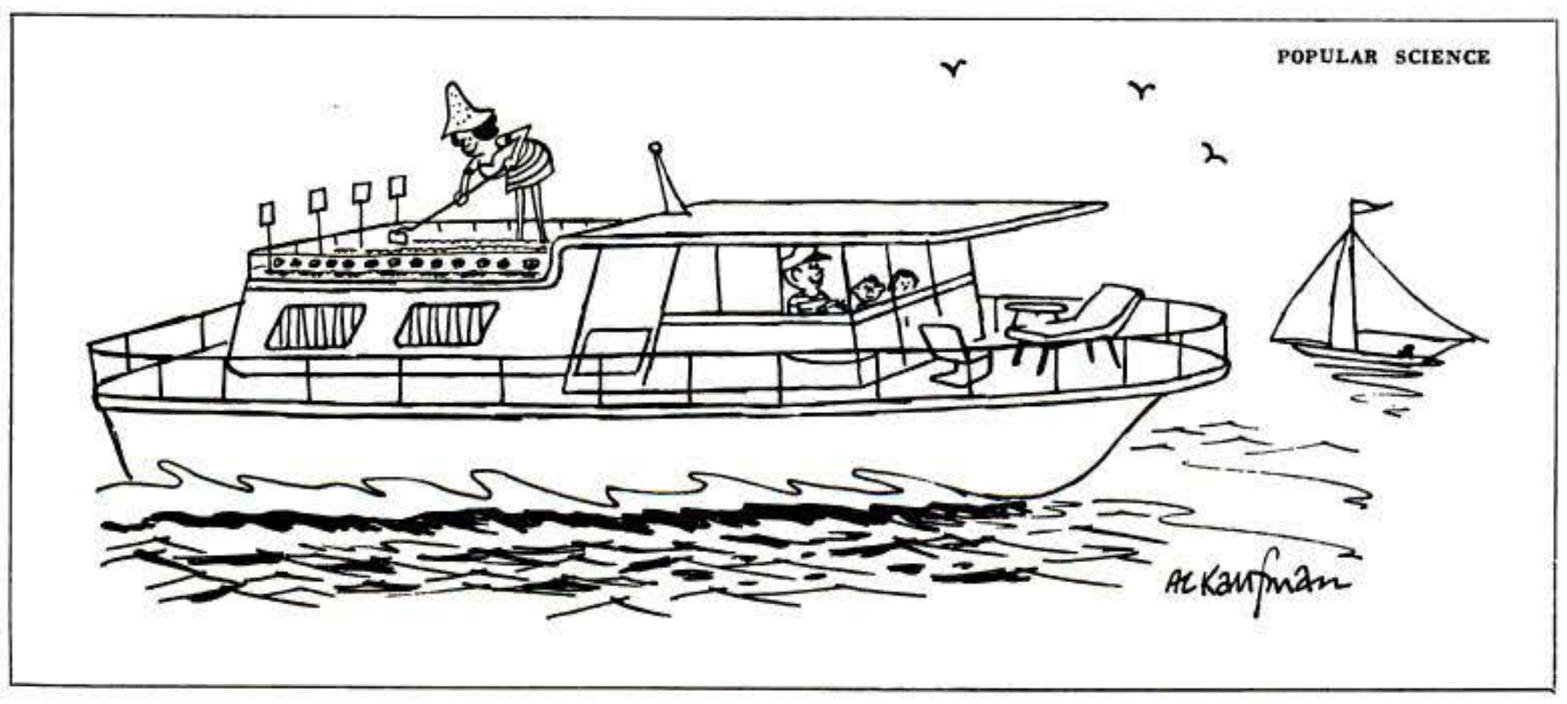
Trim, skive, and burnish. Once the film is in place trim to exact size with the knife. Hold the knife at about a 45-degree angle as you cut, and tug a bit on the excess film to keep the cut area taut. Incidentally, save the backup paper and reattach all cutoffs. Even the smallest piece of this stuff will come in handy on other jobs.

After the trim cut, skive and burnish as shown in the photos. The whole idea is to smooth and reduce the edges so work can pass over with minimum hindrance. This is especially important on such things as inserts where even normal passes will tend to butt the film.

It's possible, despite all your precautions, to damage a leading edge. Should it happen, just cut out the damaged area and burnish down the new edges.

We could list hundreds of applications in addition to those already called out and to those shown in the photos, but just to get you thinking, here are a few others that we've tested . . .

- At the hitting end of cue sticks (if pool's your game) for easier sliding between fingers.
- On the underside of rulers on drafting machines; also on angles, french curves, etc.
- A small section as release surfaces on drafting tables.
- On the rail of a sliding door—wood, glass, aluminum, whatever.
- As a table covering in darkroom and labs where acids or other caustic solutions might attack and damage the table surface.
- To line a drawer where you keep oil-soaked sharpening stones so the oil won't penetrate the wood. PS



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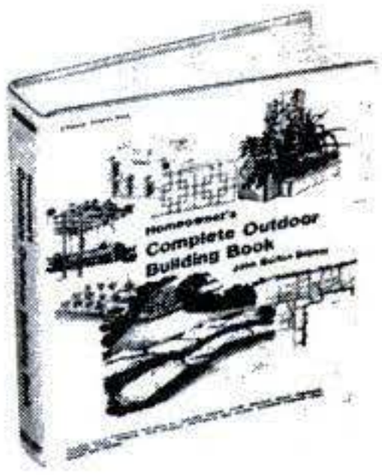

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Take-Along Telephone

[Continued from page 62]

signal and switch you to other transmitters and receivers. It may also change your channel if you approach another portable on the same frequency. The inaudible switching takes place in a few thousandths of a second.

Adjusting power output. Also as you move around, Dynatac will use automatic output control (AOC) to adjust your portable's power output, minimizing interference and conserving battery power. When you're close to a receiver you won't need much power. Each base transmitter sends signals to your unit's supervisory section, telling it to crank transmitter power up or down.

When you've completed your call, you push the ON-HOOK button. This sends digital data to the processor, telling it to "hang up"—break the connection—at the phone exchange.

What about incoming calls? Say you're in a taxi with your portable inside an attache case. A call to your portable's number comes into the telephone exchange and is sensed by the central processor. A computer sends out a digital code unique to your portable over every transmitter in the city. Your portable, on standby, picks up the signal and sends back data saying, "I'm here."

Now that the central processor has located your portable, it sends out another signal—now from one transmitter. This data switches your portable to a talking channel and tells it, "ring your bell." You push the OFF-HOOK button to answer.

Pending FCC approval, Motorola hopes to install a 10-to-20-transmitter system in New York at a cost of $5 million. Motorola, however, expects to supply hardware to phone companies here and abroad rather than operate Dynatac systems itself.

Crowded spectrum. The company faces stiff competition for the new block of radio spectrum. Two years ago, AT&T proposed a mobile or car system. Other users of the overcrowded lower-frequency bands —fire, police, taxis—would like to expand, too. Dynatac would use a small slice of the new spectrum.

Costs to subscribers would be similar to current mobile-phone rates initially: $60 to $100 a month. Later, with high-density use, monthly rates could drop to $30 or less.

The portable's size will undoubtedly shrink, also. Eventually, the unit could fit your shirt pocket. Dynatac's computer-controlled network may well be a forerunner to a Dick Tracy-type wrist-phone system you may wear one day. PS

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Trailer Mirrors

[Continued from page 111]

dapt door mounts instantly to any ar, and permit the fastest installa- on and removal. They require no djustment or modification to switch hem from car to car.

Big-time towers. Trailerists who pend a lot of time behind the wheel enerally favor fender-mounted mir- ors. They must be adapted to each ar, so are more trouble to put on the rst time. But they're steadier than he resilient-mount door mirrors, and hey can be watched without turn- g the head. A tall driver can ad- ust them downward out of his nor- al line of sight, too.

Increasingly, trailer haulers are dopting convex mirrors to expand heir rearward viewing angle. These an't be used to replace standard flat irrors—convex mirrors disorient istance perception. They work out est in conjunction with flat mirrors; he convex mirror gives the broad iew, the flat one the details.

Small stick-on convex mirrors of- er only small images, and sharply educe the size of the main mirrors. eparate convex mirrors are better. ut they must be big. Round mir- ors on fender mounts should be at east six inches in diameter, and ight might be better.

New designs, too. Recently, a olorado company with long experi- nce in making convex mirrors intro- uced one expressly for trailer tow- g. It's the Strohmeier See-All, a ghtweight (Plexiglas) mirror that ould be seven inches in diameter if he top and bottom weren't cut off a four-inch height.

It's steady, and respects a driver's orward vision. Used in conjunction ith a standard fender-mount mirror nd a Tekonsha antivibration kit, it ay well represent the height of cur- ent trailer-mirror art.

Another new design is the McKesh irror sold by Wally Byam (Air- ream) stores. This one can be ounted either on fender or cowl ahead of the door, behind the heel). It has a square, recessed ead, offers a good field of view with- ut convex augmentation, but is sub- ect to some fluttering from its nylon- ebbing anchor.

Because drivers differ in height nd seating position, fender-mount irrors will continue to be individ- alized. Some drivers, for instance, ke their mirror heads horizontal for wider rear view; others turn them ertically for a good view up the road ehind.

By drilling extra holes or trans- osing parts, you can custom-fit a ender-mount mirror to your needs. t pays to experiment. PS

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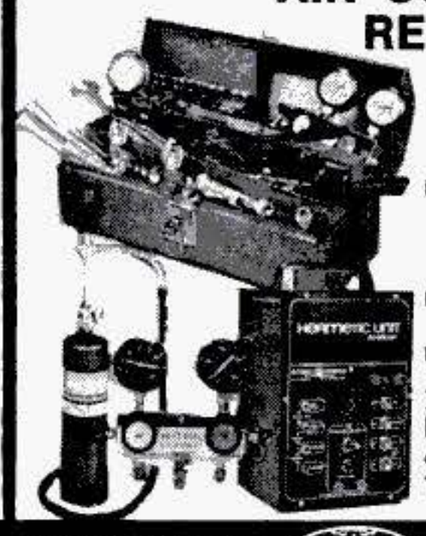

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Keep Your Pool Water Swimmable

[*Continued from page 106*]

pH tester, or have your pool supplier test a water sample.

An overall system of water treatment is usually your best bet for avoiding problems. If you use one brand of products, you can probably get a complete "system" guide booklet from the maker, keyed to the formulas.

System setup. If you plan your own system, base it on the following general sequence:

(If the pool has just been filled, and the water is hazy, the filter may need cleaning several times a day for the first few days. So check the pressure frequently.)

1) Start-up treatment. With the filter running, check the water's pH, and adjust it if necessary. Then add "stabilizer" according to the maker's instructions for the gallonage of your pool. This is a form of cyanuric acid (usually crystaline) that locks on chemically to the chlorine that is added later, greatly reducing its dissipation from the water.

If you use a chlorinated stabilizer it also supplies a good initial dose of chlorine. Add this type in the evening and the residual should test at the recommended level by morning. If you then use a stabilized form of chlorine to maintain the "residual," the initial dose of stabilizer will usually last indefinitely.

Chlorine compounds in quick-dissolving granular form let you increase the residual level quickly, merely by "sowing" them in the pool. Others, in tablet form, dissolve slowly in floating dispensers maintaining the residual with less frequent doses. Automatic chlorinators (Clor-Trol is one make) meter chlorine from tablets or cartridges into the filter's return flow. They're around $30 at pool suppliers.

If you use an unstabilized chlorine form, stabilizer must be added periodically to keep the cyanuric-acid level between 30 and 50 ppm. (Use a cyanuric tester, or take a water sample to your supplier.)

Keep the pH in the correct range, as described earlier, and maintain the chlorine residual at the ppm level specified on the chlorinating product you use. (The common unstabilized chlorine compounds, like calcium hypochlorite, tend to raise the pH, as they contain an alkaline element. So occasional acidifying is likely to be required. (Lithium hypochlorite, used for the same purpose, is less alkaline.)

2) Shock treatment. Super-chlorination is overdosing of the water with chlorine (typically three to five times the usual dosage) at about two-week intervals. This kills off organisms resistant to the normal residual, and also oxidizes residues from swimmers that otherwise build up a haze in the water.

Apply the overdose in the evening when the pool is unoccupied—*not* through the filter, but leave the filter running. The residual should test at a normal level (usually by morning) before you use the pool.

3) Algae treatments. Most types are killed off by the chlorination steps described, but algae can reach problem levels very quickly in warm, sunny weather, before they show. (The spores seldom are apparent until they number *30 million per ounce* of water.) Clues to their presence: a greenish look to the water and a slippery pool bottom. To play safe, don't wait. Use an inhibiting compound from your pool supplier.

Precautions: Never mix pool chemicals (some react violently) or add more than one to the water without allowing the specified time interval. And store pool chemicals (especially chlorine types) where other chemicals or household liquids cannot be accidentally spilled into them.

Cleaning tips. Your pool should (and probably does) have a built-in surface skimmer to remove floating material (like leaves) before it can enter the filter. A long-handled, hand skimmer net helps, too.

Do all vacuum cleaning of the bottom from the pool rim insofar as possible, since walking on the bottom churns up the sediment you want to remove. Calcium hypochlorite and similar compounds leave a fine precipitate on the pool bottom that must occasionally be vacuumed.

Black algae, if allowed to gain a foothold, can complicate pool cleaning, as they form unsightly spots on the pool walls or liner. To remove, brush vigorously with an algae brush made for it. (This opens the buds for better chemical penetration.)

Then use an algae killer; Spot Kill is one popular brand. You shut off the filter and allow pool circulation to stop—usually in about two to four hours. Then sprinkle the algae-killer granules as close to the brushed spots as possible, using the total amount of chemical specified for your pool's size. Let the chemical work overnight, brush off the dead algae, and vacuum to waste.

Compounds to kill floating green algae are usually broadcast into the pool in the evening and allowed to work overnight with the filter running. The dead algae are then vacuumed to waste in the morning. The filter may then be cleaned, too. PS

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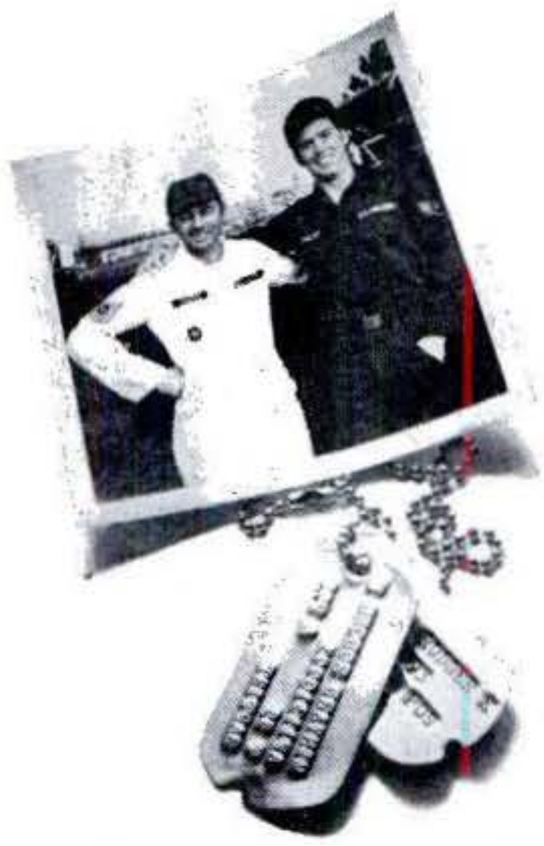

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How Science is Solving the Mystery of the Northern Lights

[Continued from page 84]

take place within the next hour."

What happens? Does the reversal allow more particles to flow in? Is there a charging and discharging of some sort? Or does increased flow *cause* the reversal? He shrugged.

"Hey—look at that!" Whalen pointed forward. "Isn't that peculiar? I've never seen the form before." A snake-like band twisted off toward the horizon, while other stabs of light pulsed around it. "Everything is on such a vast scale it's difficult to figure out the basic pattern. That's why satellites are so important—to give an overall topside view."

And then, almost on cue, a satellite—probably ISIS II—sailed across the field of Smitty's TV camera. "That's 1400 km out," said Whalen, "and is measuring inbound auroral particles. And another one, called Vela—about 144,000 miles out—should be passing through an interesting section of the magnetosphere right now, making particle counts."

Those counts, with photos taken by other satellites, along with data collected by us and by ground stations stretching along our flight path, eventually would be correlated to see what effect events 100,000 miles out have on the ionosphere. "What I'm looking for," said Whalen, "is some relationship between the aurora and the plasma sheet particles—changes in both simultaneously, because that might tell us just where the sheet (the long "tail" of the magnetosphere) is tied into the oval. I'll be very disappointed if we don't throw some light on it."

ISIS slowly slid off the screen (and out of the overhead sky) and suddenly the tube erupted in starbursts and pinwheels—a July 4th fireworks climax. Actually, the spectacle was invisible offscreen. The sky was almost dull by comparison. "Maybe we'll find the really important aurora to be subvisual—low-level radiation the human eye can't detect," said Whalen.

Scientists at work. Around the ship, the other scientists had been concentrating on their equipment. Whalen pointed out to me what was happening:

- Up through a dome in the plane's center pointed an "all-sky," fish-eyed camera. Its view was 160 degrees, taking in all but the horizon. One frame was being automatically snapped every minute.
- The horizon, meanwhile, was being photographed by a Beattre-Coleman camera pointed out the side. (Each exposure was 20 seconds at *f* 0.95 on ASA-160 film.)
- Toward the front, Rosemarie Wagner, an expert on subvisual aurora (and a former meteorologist in prewar Germany) was intent upon what looked like a TV picture tube with a grid across its face. Once a minute a sweep was made, leaving behind echoes of the upper atmosphere.

This "ionospheric sounder," she explained, sends up radar pulses that rise in frequency from two to eight mHz. The purpose: to detect heights of the "E" and "F" layers of the ionosphere, "zones of disturbance" produced by the particle bombardment, where most auroral activity occurs.

Off behind the equipment, making some internal adjustment, was Bob Gowell, the chief engineer. "He's been on the program longest and he's our secret weapon," said Whalen. "The Russians have a flying aurora lab, too, but their overall results haven't been very impressive. That's because Gowell is the only one so far who can make a mobile ionospheric sounder work."

Toward the rear of the plane, a blinking photometer was recording light intensity in four specific frequencies, which helped explain what was happening above.

Even without a photometer, Whalen told me, you can tell something about auroral heights by watching colors. Green is usually produced at about 130 km; red appears at about twice that. Another red occasionally can be seen at low altitudes—say 90 km at most. Sometimes you even see long shafts of aurora with red tops, greenish middles, and red fringes around the bottom.

The flight was nearly over, the cameras full, the graphs lined—enough data accumulated to last a year, said Whalen. "This is an exciting time to be studying the aurora. It's an enormous challenge to make any sense out of it at all—and yet some things are falling into place. When the pattern clears, when we understand the relationship between, say, sun spots and increased particle activity in the magnetosphere and radio blackouts at specific areas of Earth, maybe we can predict them.

"I can see us monitoring a satellite which notes increased particle activity, and we see where it is and warn Thule, Greenland: Expect a radio blackout in an hour; send anything important now, because you'll not be able to for long.

"Such a time is coming quickly, I think. It isn't quite here yet, but the outline is—and now what we've got to do is fill in details." PS

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Sunglasses

[Continued from page 99]

ıg, working, shopping—all without ver being conscious of a light prob- em. Great! Their possible lone draw- ack came while driving. Because nly ultraviolet light will stimulate ıe photochromic action, darkening somewhat restricted inside an auto- ıobile, especially one with tinted indows. Under some conditions— hiefly driving into a low sun—the pecs had faded slightly lighter than 'd have wanted them.

Because of the UV stimulation fea- ıre, photochromic sunglasses are ot turned on by ordinary house- old lamps, auto headlights, or other ıcandescent lighting. Fluorescents ave a mild darkening effect.

Effective variable transmittance for unglasses is so new that the indus- y is having trouble coming to terms ith it. Lest you become confused: Corning Glass this year changed ıe name of its photochromic lens lass from the old name, Photosun, Sunsensor *dark*. Trouble is, the unglass industry is still advertising s products with Photosun lenses. ither name's the same product. The ormer Photogray lenses are now alled Sunsensor *light*. They're too ght to be called sunglasses.

Rayex markets sunglasses with yellow-green plastic lenses that turn blue-green on exposure to the sun. In my tests with a photographic light meter, the "darkened" blue-green tint transmitted a little *more* light than the "faded" yellow-green did. The Rayex shades are labeled "Photo Chromatic," which seems accurate, because they do change color, though somewhat misleading because the name sounds like photochromic.

Most sunglasses cost $2 or more. Get-by quality ones, you'll find, go for $5 and up. Marshall Field, in Chicago, advertises a pair for $55, and you can spend even more than that if you wish. Remember, though, that price is not a sure guide to lens quality.

The surest place to get the higher-priced ophthalmic-quality sunglasses in plano or prescription is from an optometrist. What if you have to buy in a store?

Store-testing. That rack of sunglasses is a high profit center. What should you look for before you buy? Bausch & Lomb, high-quality manufacturer of optics, offers these tips in a booklet on sunglasses, which you may have by writing to 635 St. Paul St., Rochester, N. Y. 14602, for one.

Put on the glasses and look in a mirror (often furnished nearby). If you can see your eyes quite clearly, the sunglasses are too light for proper glare protection. They should feel right, particularly at the nose, cheeks, temples, and over the ears. If they press uncomfortably at any of these points, the frame needs adjusting or the style is not right for you. Lower your head to make sure the glasses will stay on when you're moving around.

Check temple width. Does it obstruct your vision? This is vital if the sun specs are to be used for driving. Incidentally, you should never wear sunglasses when driving after dark. Also, be sure to remove them as you come indoors—day or night.

I particularly liked four of the sunglasses I tested: both the American Optical and Renauld photochromics for every use but driving; the B&L Caravans for their looks, fit, and fine quality; and the Cool Ray Polaroid Fast Backs for their feather weight and polarizing feature. I'd have chosen the Opal-Lite Passports, too, except that the lenses on the model I tried passed a bit too much light. PS

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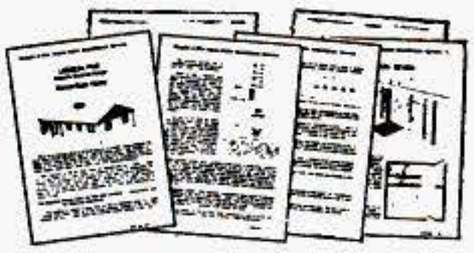

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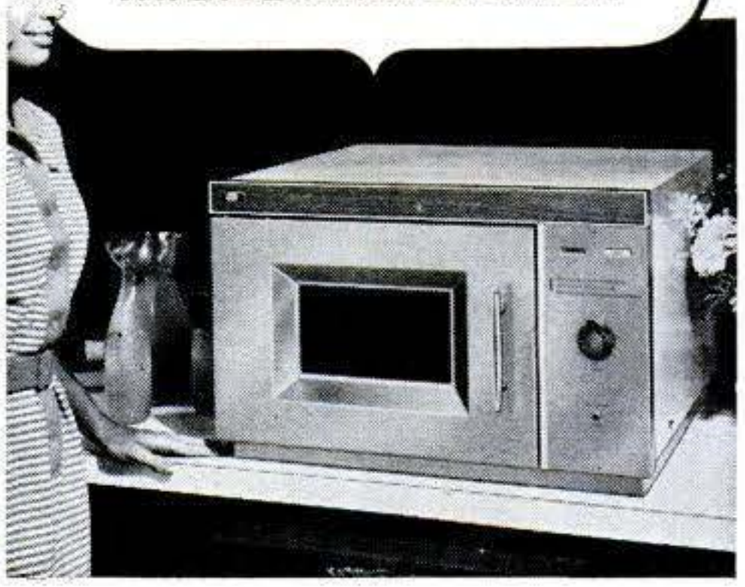

People on the go will welcome an oven that makes cooking chores a pleasure. Imagine a "piping hot" TV dinner (frozen) in 3½ minutes* instead of 20 to 50 minutes. Bake a potato in 5 minutes* instead of 60 minutes. Fry crisp bacon in 90 seconds on a paper plate. Great for those leftovers. Countertop designed. Works on 115 vac house circuit. Write for folder.

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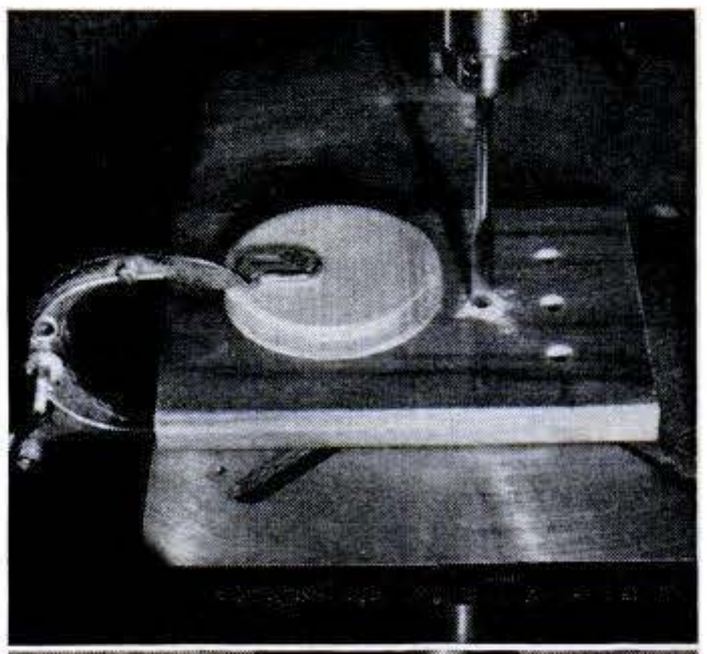
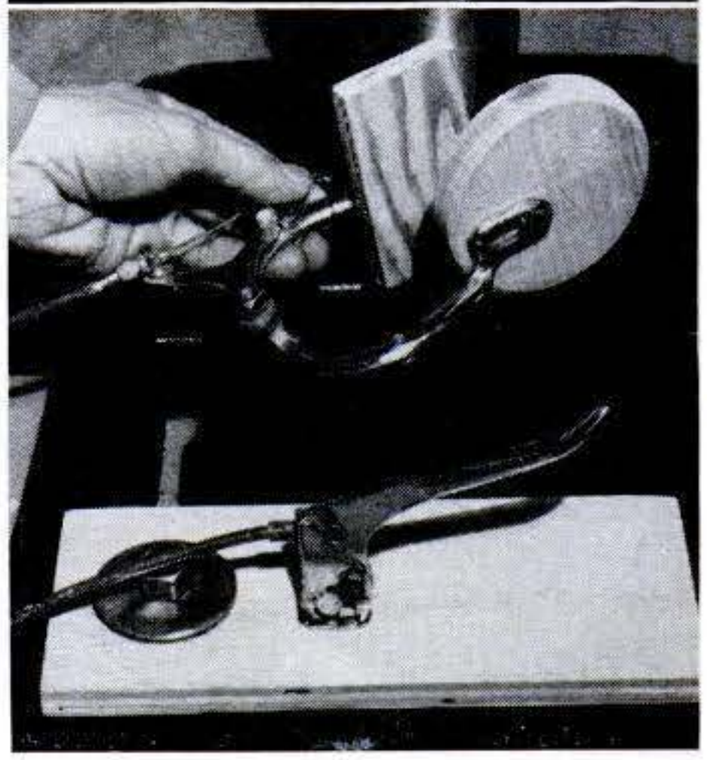
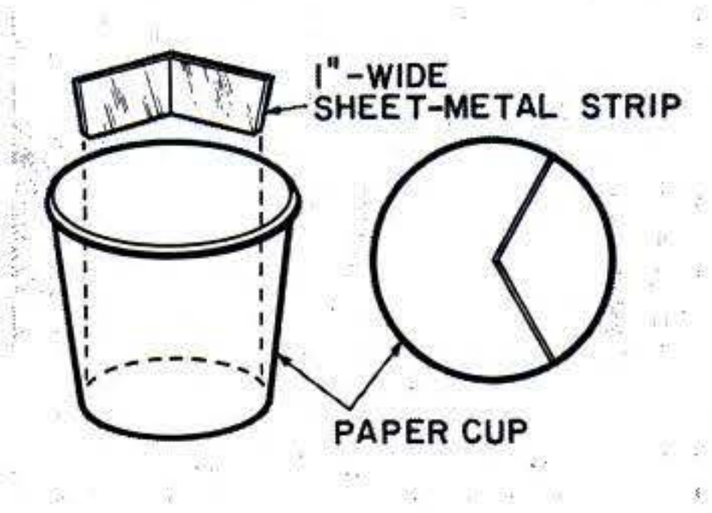




Bike-brake clamp

Here's a handy foot-operated hold-down for your drill press, made from an old bicycle brake. Bolt the brake handle to a 4"-by-9" piece of ½" plywood. Drill a hole near one end of the plywood and bolt that to the base of your drill press. Screw a 2"-by-3½" plywood block to one jaw of the brake, and a 3½"-diameter wooden disk to the other jaw. Fasten the disk a bit off center so it can be swiveled for best positioning on the work.

JORMA HYYPIA, Greenwich, Conn.



Mixing two-part batches

A partition assures an accurate powder/liquid mix (as with resorcinol glue). The degree of angle on each side will depend on the volume ratio called for; equal parts form a straight partition. Pour powder in on one side and tap the cup to settle at partition height. Remove the partition with tweezers and pour in liquid, flush with the top of the powder.

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The first National Hunting & Fishing Day, September 23, 1972 saw some 4 million people visiting Open Houses hosted by over 3,000 sportsmen's clubs throughout the country.

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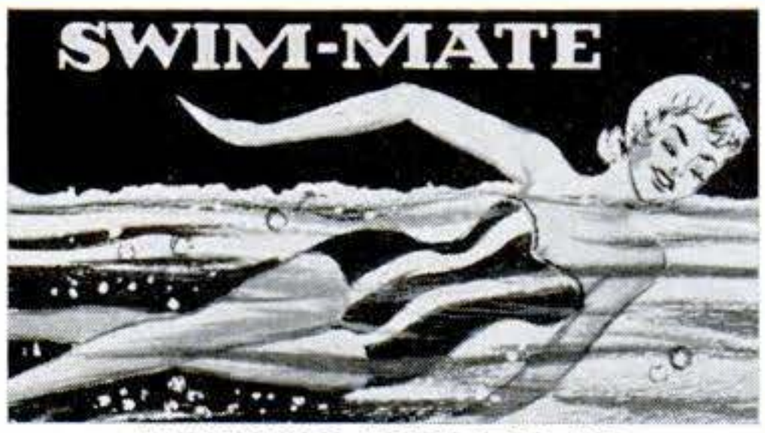

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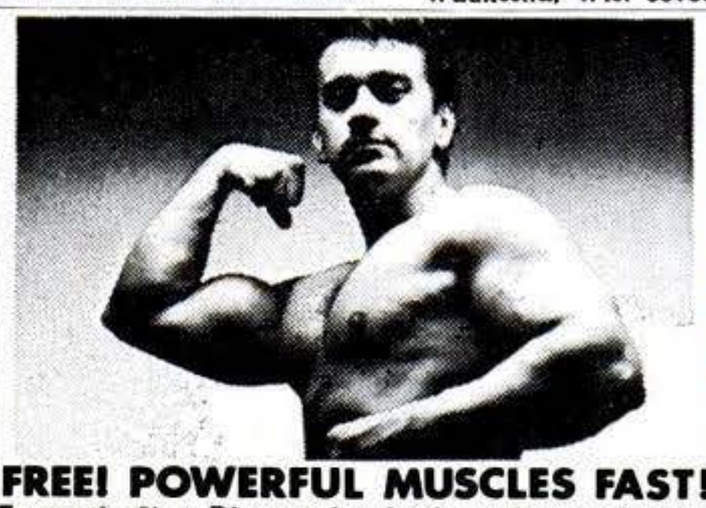

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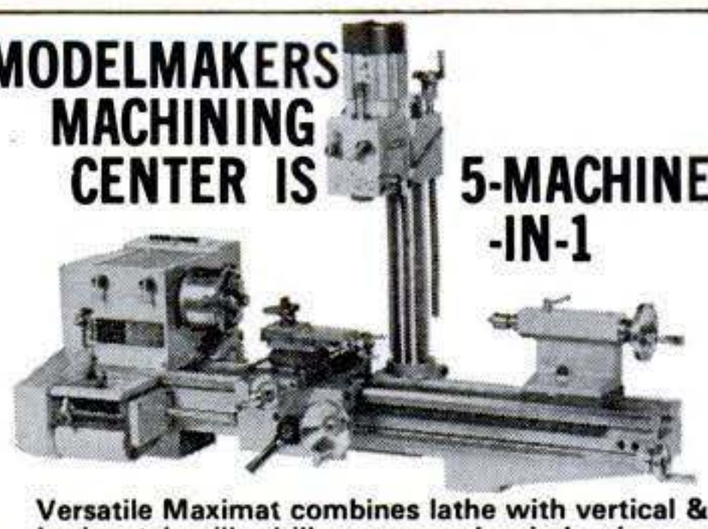

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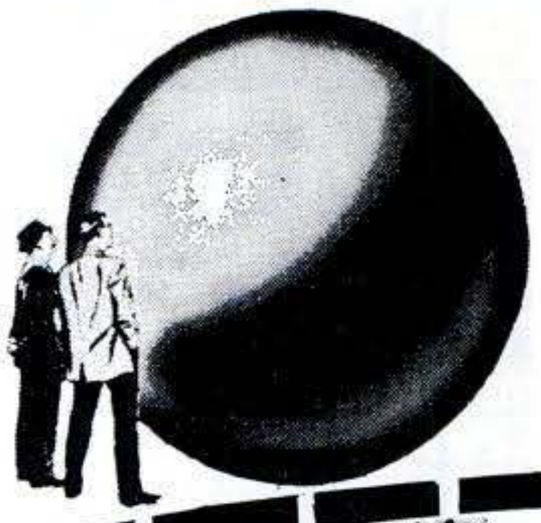

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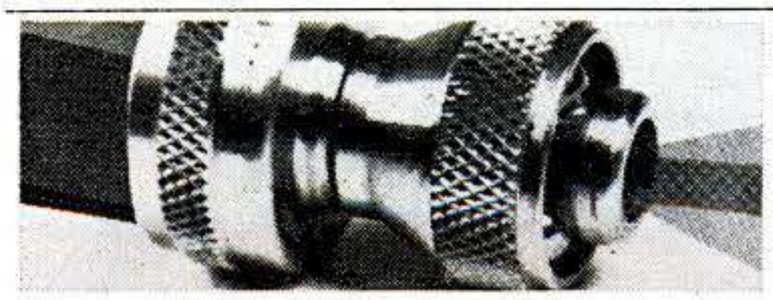

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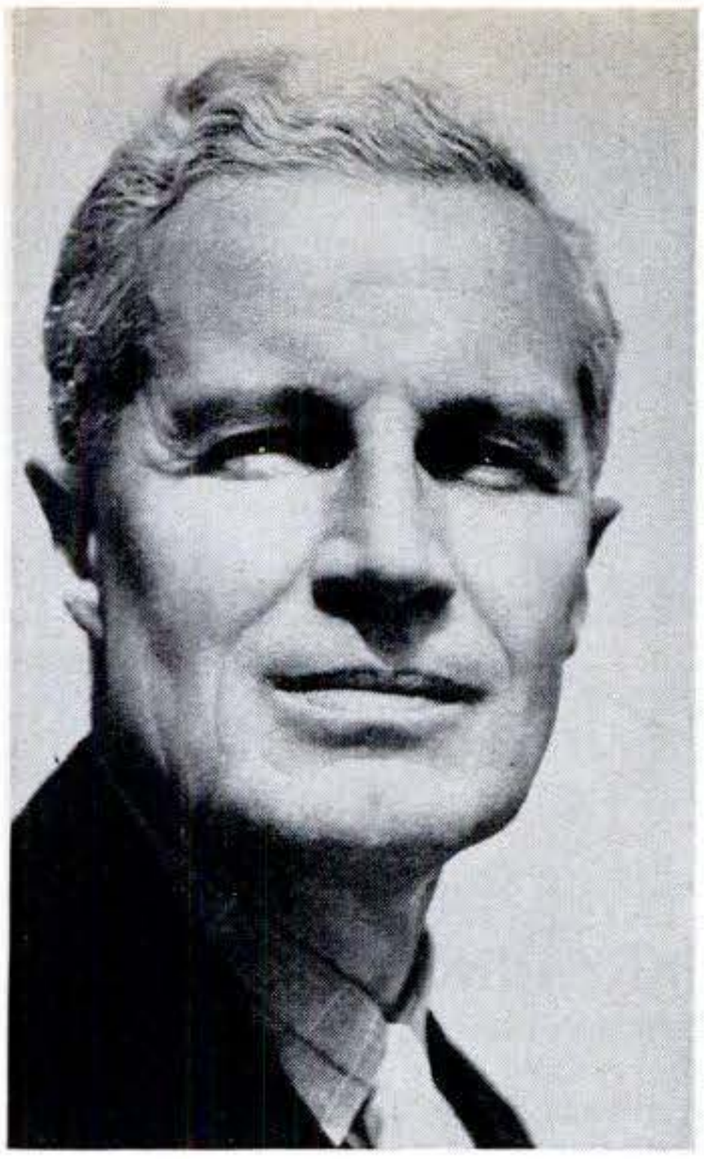

I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be — today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest $15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

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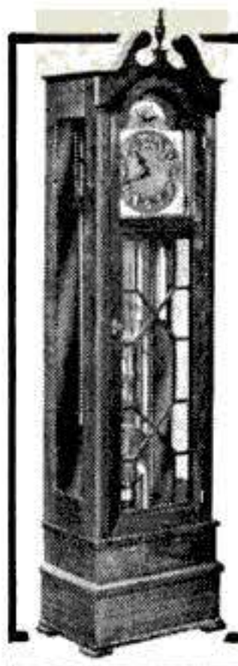

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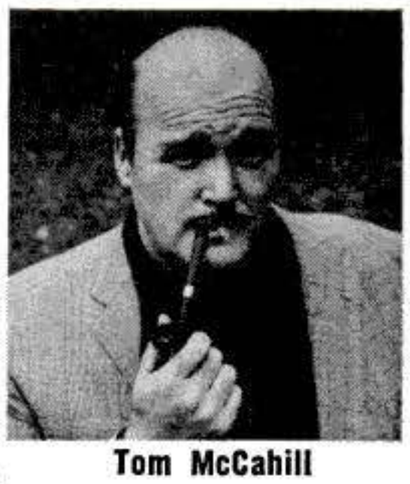

Tom McCahill

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AN EXPERT ANSWERS YOUR QUESTIONS ABOUT MUSCLES

Our files show that thousands of readers like yourself want to build bulging muscles and achieve real physical power like their favorite athletic champions. How to go about it? We decided to ask an expert, Dave Prowse, 3-times British Weightlifting champion and leading fitness expert. Here are his answers.

Q. *What does it take to build muscles?*

A. Basically, it takes exercise. Almost any exercise will help to develop at least some of your muscles if you keep at it long enough and hard enough.

Q. *Isn't there an easier way?*

A. Yes. There is one outstandingly effective training method that is also fast and easy—the one I use and recommend—the new Bullworker system.

Q. *What's that?*

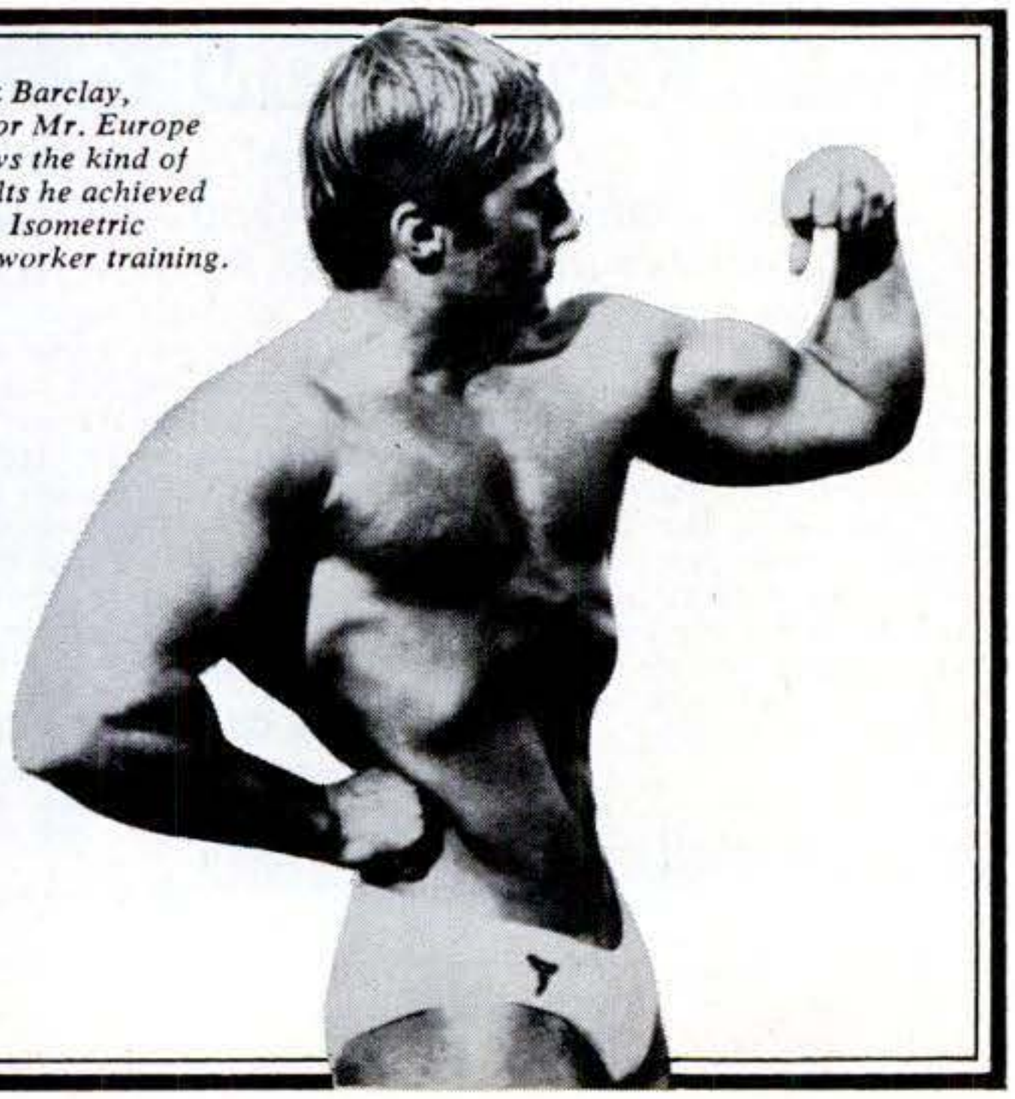
A. The Bullworker is a revolutionary new muscle-building exerciser based on Isometrics, the science that increases strength up to four times faster than conventional methods. In my opinion, it's the most advanced training system in the world today. Many leading athletes use it: World-famous Heavyweight Boxer Muhammad Ali, World Heavyweight Judo Champion Wim Ruska, and Cycling Champion Eddy Merckx, to name only a few.

Q. *How long does Bullworker training take?*

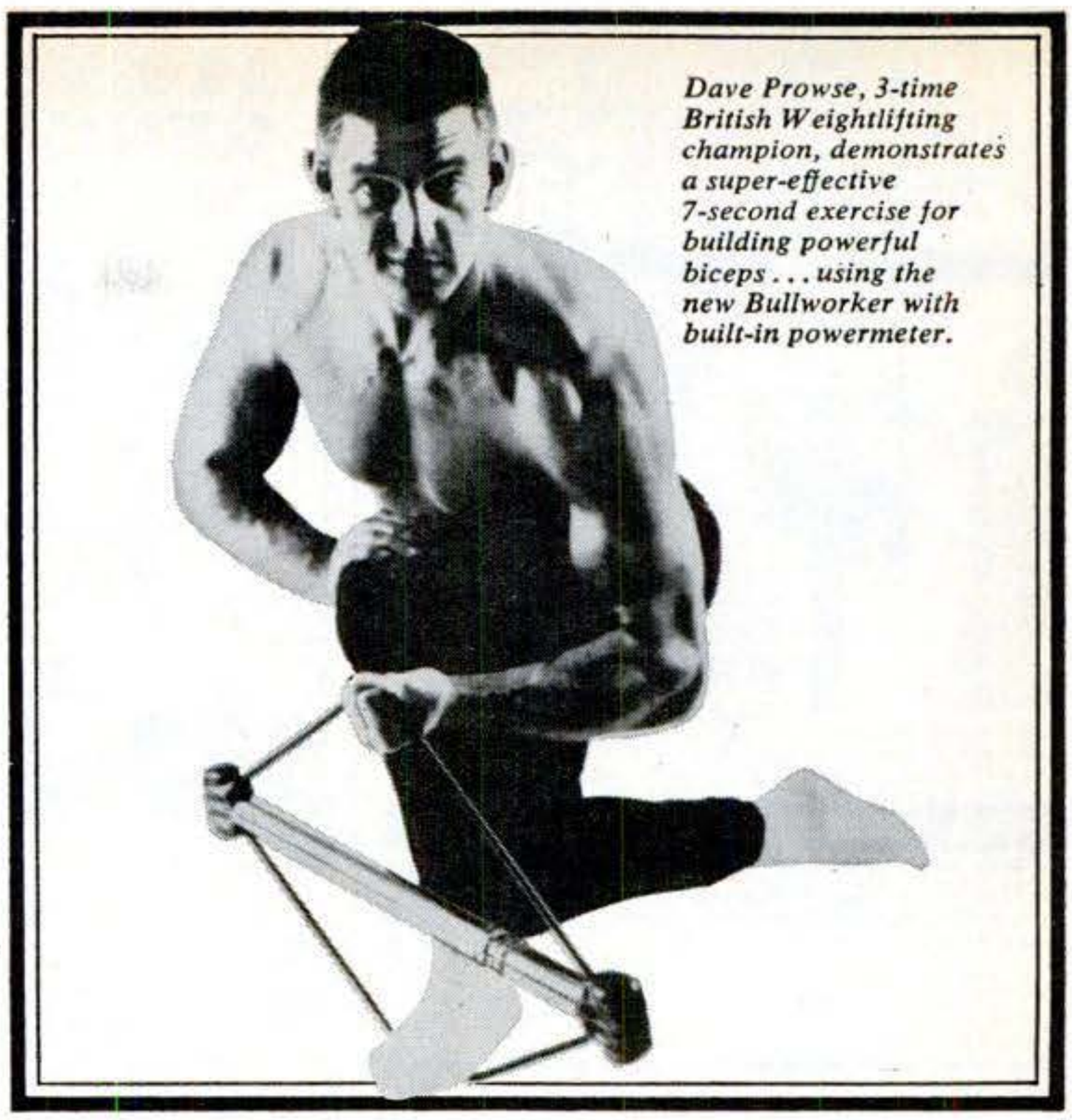
A. Bullworker provides absolutely the fastest kind of exercise possible. In fact, an introduction training program takes only 70 seconds a day. No other system—weightlifting, pulleys, or strenuous calisthenics—can give you results so quickly and easily. On the contrary, many old-fashioned methods take hours of sweaty, boring work each day...and it's often months before you begin to see improvements. Busy professional athletes and champions don't have time for that. Nobody does.

Q. *How long does it take before you begin getting results?*

A. With the Bullworker, you can actually begin to see and measure the positive results right from the very first day! Thanks to a built-in measuring device called the Powermeter. After every exercise you just check the reading to see exactly how much your strength has increased from the day before. There's no guesswork involved. Isometric Bullworker training can increase your power at the amazing rate of up to 4% per week! That means a 50% increase in strength in the first three months alone. And I've known many young men who have gone on to double and even triple their strength.



Jack Barclay, junior Mr. Europe shows the kind of results he achieved with Isometric Bullworker training.

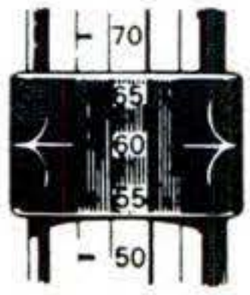


Dave Prowse, 3-time British Weightlifting champion, demonstrates a super-effective 7-second exercise for building powerful biceps . . . using the new Bullworker with built-in powermeter.

Q. *What do those figures mean in visual terms?*

A. They mean that in as little as 14 days you can actually begin to *see* muscle growth in a mirror and *verify* it with a tape measure. Every week thereafter brings ever faster growth.

Built-in Powermeter
You can actually measure your musclepower g-r-o-w-i-n-g from the very first day.



Q. *But to get such impressive results, don't you have to work very hard?*

A. Absolutely not. That's the outstanding advantage of Isometric training...it's so amazingly easy! Each "Static-power" Isometric exercise takes *only 7 seconds,* and you barely have to move. It's not even necessary to disrobe. The Bullworker is so light and compact, it can be used at home, in the office, anywhere... even while watching TV! It's a great improvement over bulky, expensive weights, bicycle machines, pulleys, etc.

Q. *Can Bullworker training even develop bodies which are weak and skinny, or fat and flabby?*

A. Definitely! It's been proven by thousands of men of every shape, size and age all over the world. Bullworker training helps transform weak, thin arms into rippling, muscular pillars of strength, build broad, powerful shoulders, turn flat, shallow chests into deep, manly ones, forge loose stomach flab into steel-hard, well-defined muscle...build that "V" shape of a real athlete, develop sturdy, contoured thighs and calves....And all this in *record time!*

What's more, I've known skinny, shy fellows who, after just a few short weeks with Bullworker, turned into real go-getters...every inch a man...bowling girls over with their dynamism, confidence, and new found power! You really have to see the remarkable effects of Bullworker for yourself to believe them!

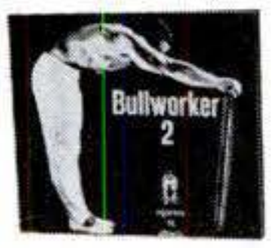
Q. *How can our readers find out more about the Bullworker, perhaps actually try it for themselves?*

A. I understand that the Bullworker distributor in the USA is now making it available—free—on a two week home-trial basis in order to introduce it to the general public. If your readers are interested in developing their bodies, in building muscles and strength faster than ever before possible, I suggest that they contact the US distributor for full details.

© BULLWORKER SERVICE,
201 Lincoln Blvd., Middlesex, New Jersey 08846

144

FREE BOOKLET



BULLWORKER SERVICE
Dept. BW-854
201 Lincoln Blvd., Middlesex, New Jersey 08846

Please send me my FREE full color brochure about BULLWORKER 2 without obligation. No salesman will call.

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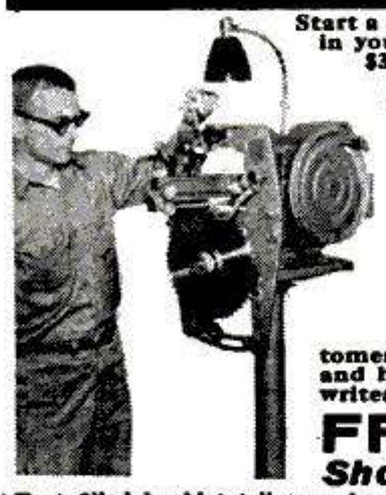

Start a steady repeat CASH business in your basement or garage. Earn $3 to $6 an hour in your spare-time! Excellent profits in saw sharpening business! Automatic Foley Saw Filer, easy to operate, files combination saws, hand, band, and circular saws. No experience needed. H. C. Deibert wrote us: "Since I got my Foley Filer 5 years ago, I have averaged 4½ saws each day since I started."

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Scare Away Would-be Thieves and Molesters.

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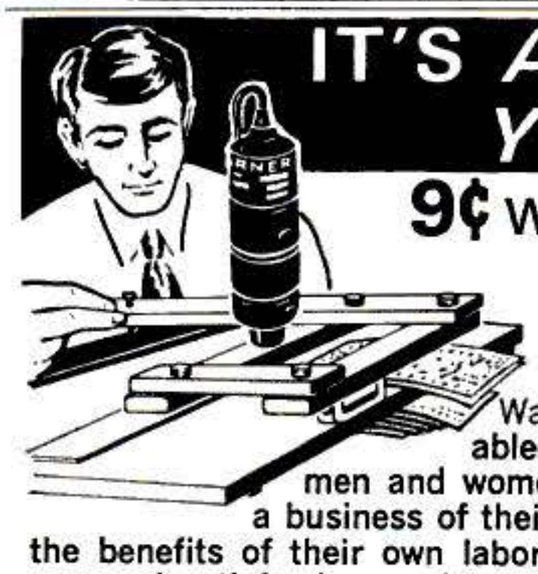

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in less than 60 seconds—and ANYONE can LEARN to do it in a FEW SHORT HOURS!

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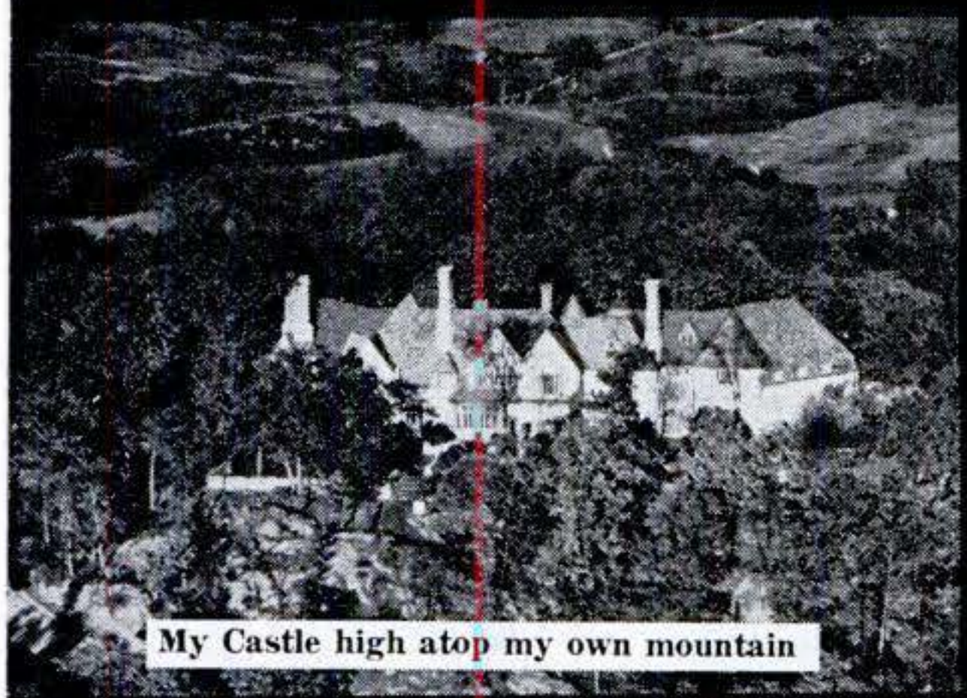
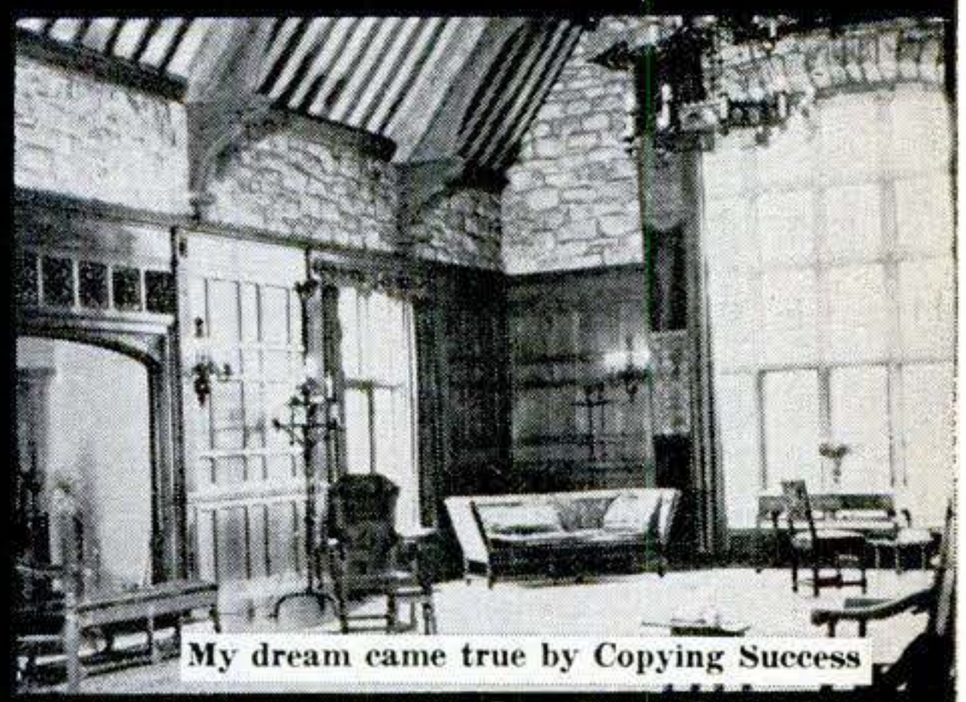


My Castle high atop my own mountain

IF YOU WANT TO BE RICH!



My dream came true by Copying Success

I WILL TEACH YOU MY SECRET OF COPYING SUCCESS!

THERE ARE 3 WAYS TO BECOME RICH. One is to be born rich. Two is to have wealth thrust upon you and Three is to achieve wealth. If you were not born rich, forget it, wishful thinking won't help. Some hope for a rich Uncle to remember them in a will. There is also the Lottery Ticket Type who reads travel folders while waiting for his number to be called. Waiting for wealth to fall on you is one of the most popular yet least successful ways of becoming rich. If this is your present system, forget it. STOP DREAMING, WAKE UP, YOU MUST MAKE IT HAPPEN!

YOU MUST COPY SUCCESS!

I have proven that a fortune can be made in a brief period if a person knows how. I can show you how to do it too. Why would I share my secret to success? Simply because it gives me a great feeling of satisfaction helping others to find their fortunes as I did. I will also probably make another fortune myself from these ads that are appearing all over this great country.

STOP USING EXCUSES NOW

Age, education, capital are unimportant in this system of making money. There are no degrees needed to be rich. I was going nowhere for years, then the opportunity to copy success came and I grabbed it, then my success story unfolded. I had problems too. I was born poor, quit school, washed dishes for 3 months and day dreamed how to make a better life. I got married and had children and worked selling everything from garbage cans to correspondence courses. I even worked on the side as a mechanic and painter. I worked 60 hrs. a week but ended up with so many debts and loans it seemed hopeless. We even took in boarders to make ends meet. I'm not talking about the depression years, I'm talking about just twelve years ago. I'm sure there are many going through the same thing, right now.

OPPORTUNITY UNFOLDED

right before me, just as this page is unfolded before you, not by plan but by chance. I was out selling and stopped into a man's office just at a moment when he was counting what looked like thousands of dollars right there in front of my eyes. I just stood there in awe for a couple of minutes just looking at all that money. It wasn't bundled like from a bank, just loose bills crumbled on a desk in a pile about a foot high. The longer I stared the bigger that pile looked. I'll never forget that day because it was the beginning of the change I needed and wanted in my life. That man was making thousands of dollars a day and he had been doing it for years. He was a millionaire. I had to find out how he was doing it. I made up my mind to copy his secret or method or whatever it was that made him rich. I went to work for that man the next day. For 6 months I watched, listened and studied everything that man did. I learned the secrets this man developed in ten years of success. I put these methods to work on a limited basis at first because I had only limited money.

THEN IT STARTED WORKING FOR ME

I got out of debt and before I knew it I had made a fortune, more money than I imagined even in my day dreams.

Almost overnight people were calling me a genius. I was written about on the front page of the Wall St. Journal. People were coming to me for advise. I had a mansion in town. I owned buildings with rents coming in. I even bought a 55 room Castle atop my own mountain with swimming pool, tennis court and gardners. I owned Lincolns and Cadillacs. My family and I traveled. We were suddenly financially successful and we did it by our secret of copying success.

I OFFER YOU OPPORTUNITY

even greater than my own. I offer to share with you my secrets for success that I have proven can work. Now I am going to ask you to send me Ten Dollars for sharing this way to wealth. The information I mail will cost me less than ten dollars and I hope to make profit (less the cost of this ad). I am sure you will not begrudge me making a profit, after all, it might make you rich. I would gladly have paid a thousand dollars 12 years ago for the key to success. You should never expect something for nothing, even the church passes the basket for directions to heaven. Never give away ideas, they may be worth millions. Start thinking right now about making money and stop worrying about losing ten dollars. Ten dollars won't even pay for a parking ticket in some cities. By the way, you can examine the information I send you for ten days and return it for a full refund if your not completely satisfied. All you risk is really an eight cent stamp.

NOT A BOOK OR FRANCHISE

I'm not offering you a stock scheme, merchandise or equipment. You won't have to leave your job knock on doors or get your friends to do it for you. No working in a cellar either. This is excellent for women too. It's possible to make more money at home than their husbands make at work.

I will not just tell you about my success story, but rather .. I will introduce you to your own!

You can have cash coming in every day even when your sick or on vacation. Even holidays can't stop the cash flow of my system. Sound exciting? You bet it is. You will need lots of confidence in my system and very little money to get started. People with little capital must have daring and be willing to take a chance if they want to make lots of money. If you have ten dollars worth of daring after reading this offer, I strongly urge you to put it in an envelope and I promise to show you how to change your life.

OTHERS GOT BACK THOUSANDS BECAUSE THEY BELIEVE IN ME AND MY SYSTEM NOT ONE LOST.

One man made $30,000 in just six months using my secrets. I taught him what I will teach you and now he is independent. People from all walks of life have used my idea: A Teacher, janitor, lawyer, housewife, chemist, salesman, secretary and even a policeman. NOT ONE EVER LOST A PENNY. I cannot promise you will make as much money as I but then again you may make more.

OPPORTUNITY IS NOT JUST KNOCKING AT YOUR DOOR ... IT'S ALMOST KNOCKING YOUR DOOR DOWN!!!

This is the chance you have been dreaming about . . . NOW TAKE IT! Your risk is only a stamp, your money is refunded if you find I'm wrong. BUT. . . . . .

$ $ WHAT IF I'M RIGHT $ $

It might make you rich.

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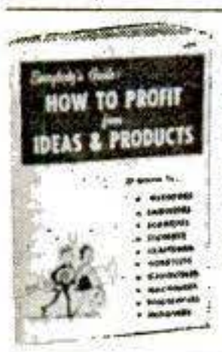

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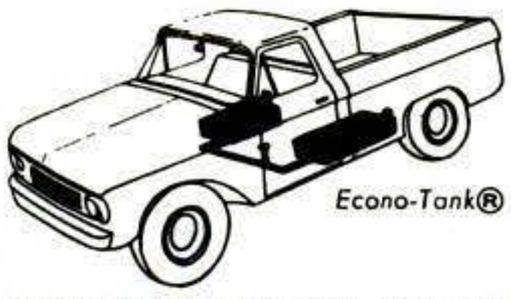

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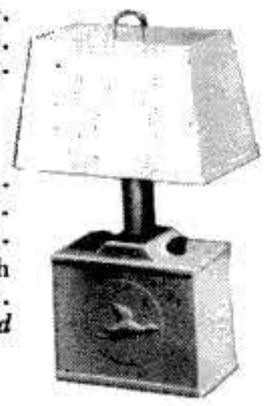

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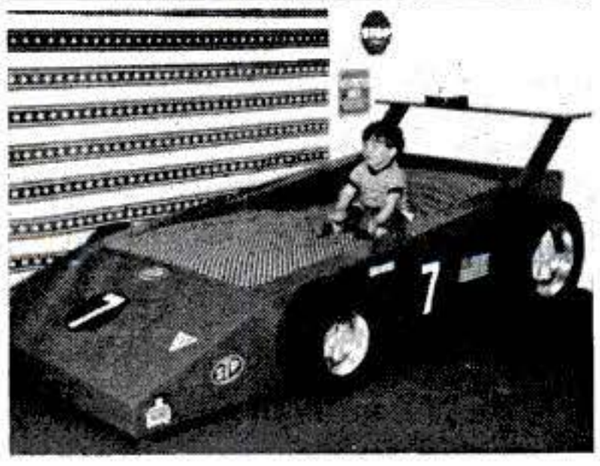

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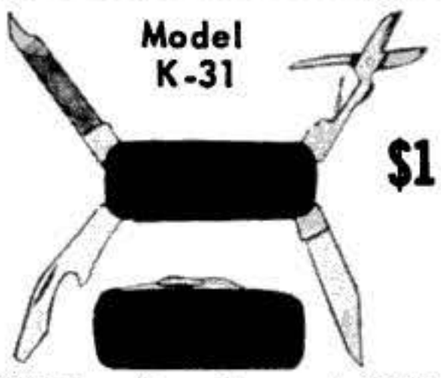

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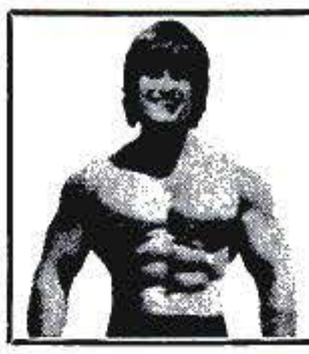

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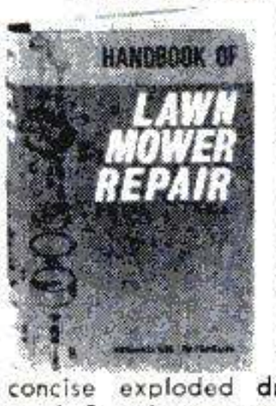

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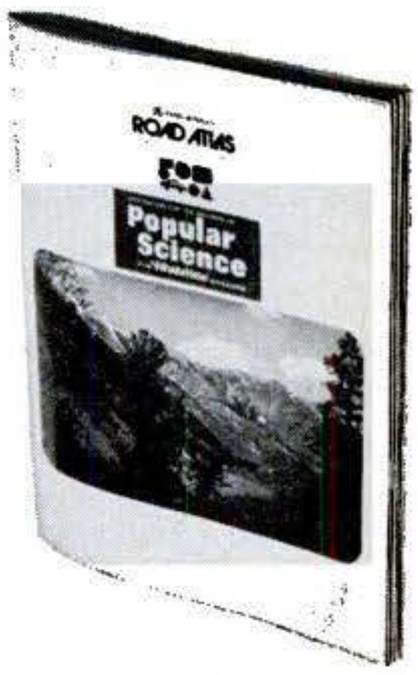

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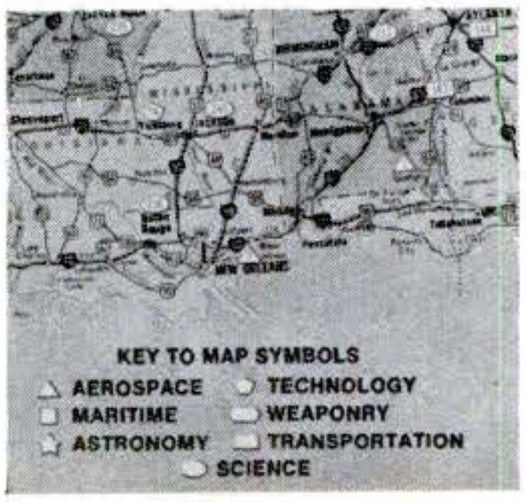

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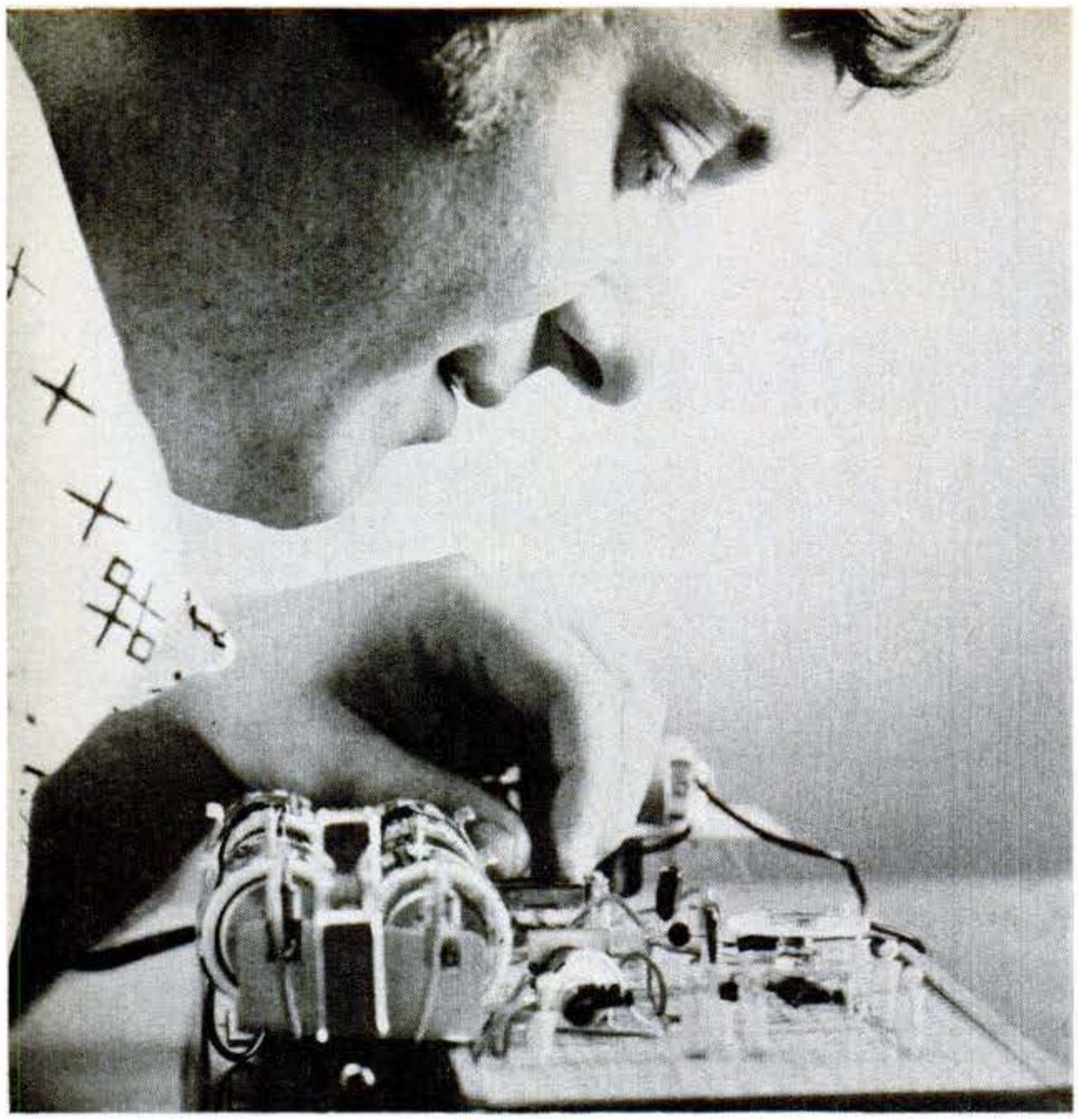

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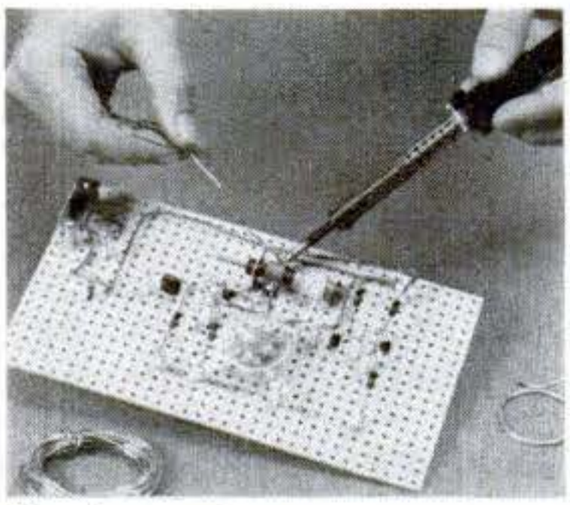

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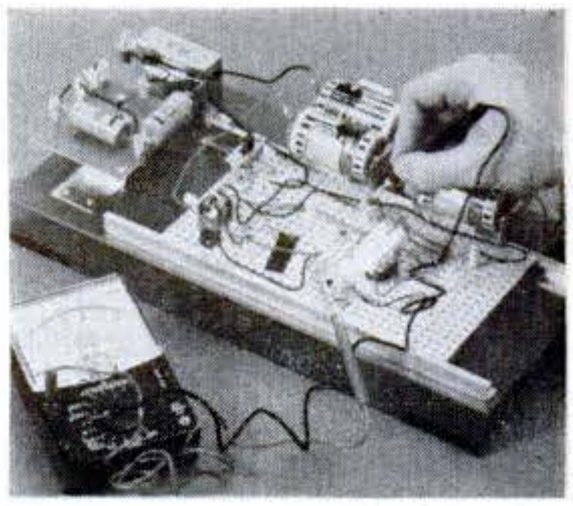

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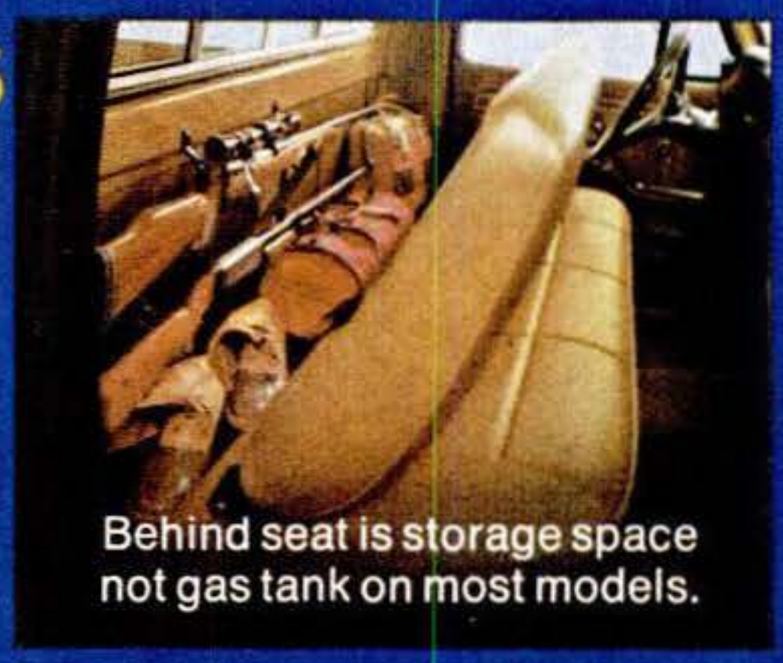
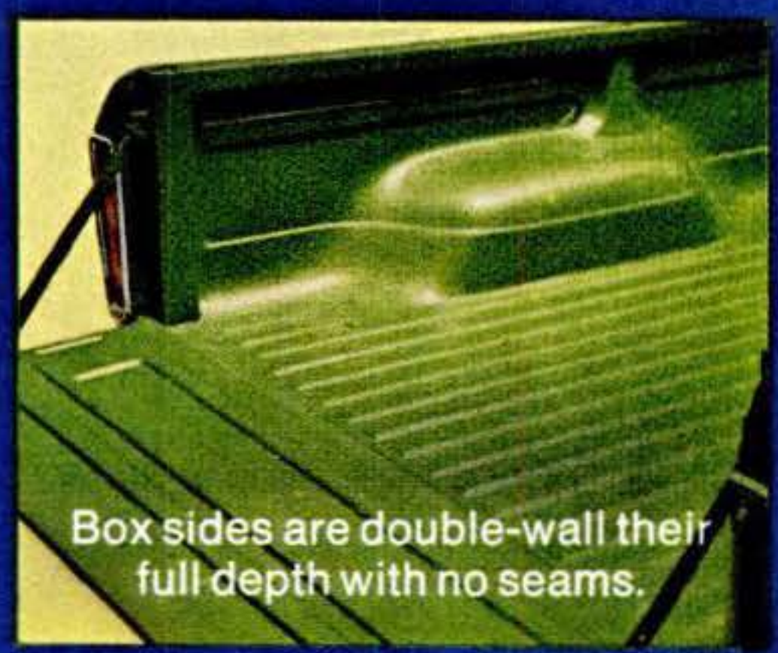
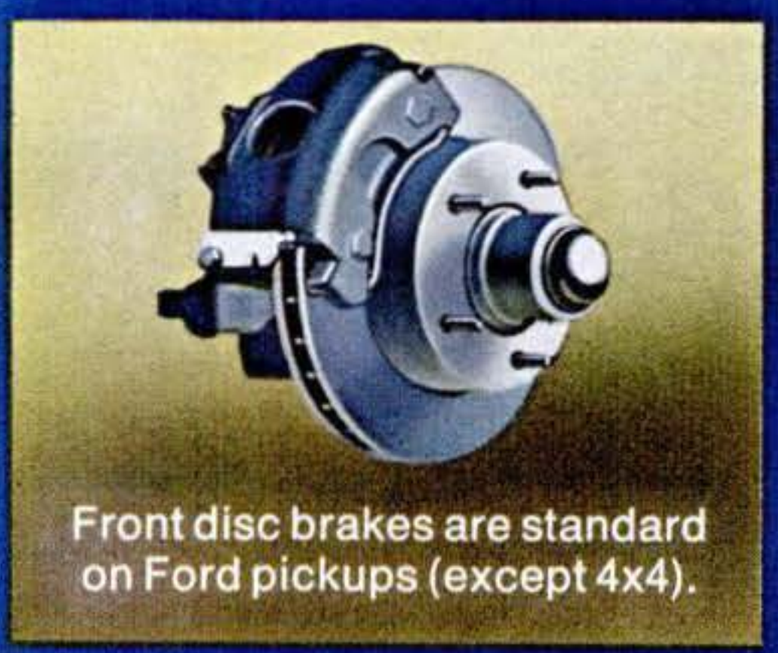

Behind seat is storage space not gas tank on most models.

Ford box cover looks and fits right, protects your cargo.

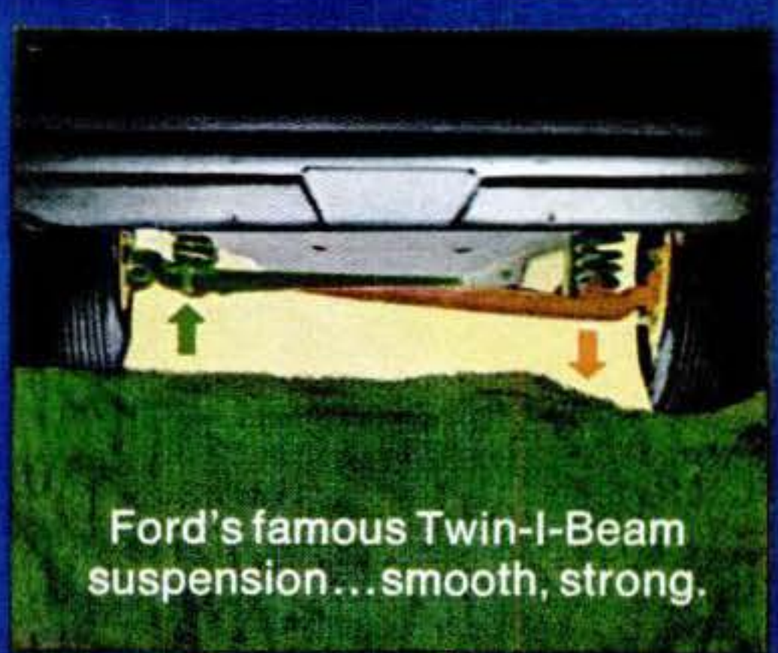
Full-foam seat over 5 in. deep is standard in every cab.

Heater is modern blend-air type; optional "air" is all built in.


Box sides are double-wall their full depth with no seams.


Front disc brakes are standard on Ford pickups (except 4x4).

Roomiest Ford pickup cab ever offers unusual quiet, comfort.


Ford's famous Twin-I-Beam suspension...smooth, strong.

A better idea for safety: Buckle up.

FORD PICKUPS

FORD DIVISION Ford

Works like a truck/rides like a car.

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Come to Marlboro Country.

18 mg. "tar," 1.3 mg. nicotine
av. per cigarette, FTC Report Feb. '73

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.